POWER

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Let There Be Light!

THE power plant in a city building, where space is valuable and where it is desirable to keep the noise and dirt out of sight, is often a dark, hot, dingy and forbidding place.

Located in a corner of a subcellar, neglected as to paint and janitor service, illy ventilated, a natural sump for evil smells and untidy accumulations, it neither invites a high class of intelligence nor inspires interest and efficiency on the part of its incumbent.

The psychological and physiological effect of environment receives too little attention. Men cannot do their best work under such conditions.

To have your pick of the good men, to keep them as fixtures in the organization and to get interested, wholehearted service out of them, to have them presentable and self-respecting, they should be given clean, bright, comfortable and presentable surroundings.

The ease with which electricity may be distributed makes it possible to flood such quarters, far though they be below the ground line, with reconverted sunlight. Motor-driven fans will exhaust the hot, foul air and fill them with a cool, healthy breath from out of doors. Light colors on the walls and ceiling will reflect and diffuse instead of absorbing the light and add to the cheerfulness. A vacuum cleaner will remove the dust instead of stirring it up to settle again. Even the machinery may be painted in light colors and will be kept cleaner because the first smooch is so much more conspicuous.

Light is a cheap invigorator. Let it in plentifully, and the cleaning up of the dirt and sloth that it reveals will naturally follow.

F. R. Low

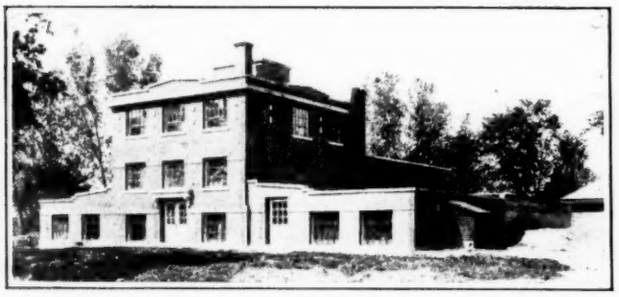


Fig. 1—Diesel electric pumping station and filtration plant at Portage, Wis.

Diesel Pumping Station, Portage, Wis.

OIL ENGINE plant shows estimated annual saving of $3,362 over purchased electric power at prevailing rates and gasoline engine stand-by. When earnings have paid for the plant, the annual saving will exceed $7,000.

ABOUT thirty years ago, Portage, Wis., built a steam-operated pumping plant on the east bank of the Wisconsin River. Duplex steam pumps drew the water supply from the river through a rough filtering box filled with sponges and discharged the water directly into the mains. For more than twenty years this station operated with apparent satisfaction, but during the summer of 1921 and for a few previous seasons, reports of considerable sickness led the Wisconsin state health authorities to investigate the water supply, with the result that the city was ordered to provide itself either with a new filter plant of modern design and construction or an underground water supply by means of drilled wells. This order precipitated discussion pro and con on the question of hard versus soft water, with the consensus of opinion favoring the latter, so that a well-known firm of consulting engineers specializing in water filtration was employed and plans and specifications were soon ready for the new filtration plant.

With the question of water supply settled, there developed a divergence of opinion on the relative merits of purchasing the power required for pumping or generating this power by a Diesel engine installed in the station. Portage was a distributing center for three different generating stations of the public-utility company serving this territory, so that a dependable supply of current was available. However, a careful analysis showed that oil-engine operation was cheaper than purchased power available at an average of 2.5c. per kilowatt-hour.

To obtain minimum insurance rates throughout the town required a duplicate source of power, so that if the current were purchased, a stand-by unit would have been needed, regardless of the number of stations feeding into the general transmission system of the public utility, the assumption being that conditions putting out of service one transmission line, might affect the others in the same way. On this basis the comparative data in Table I was prepared. A gasoline engine was selected as the cheapest source of stand-by, and comparison was made with a two-unit Diesel electric plant. The annual load was placed at 318,800 kw.-hr. No fuel or lubricating-oil charge was made against the stand-by unit. The labor was the same for both types of plant, and fixed charges of 10 per cent were allowed in both cases, this figure being determined as indicated in the table.

From the totals in the table the generating plant showed an advantage of $3,362, which was regarded as an annual profit to be deposited with the sinking fund. It was shown that these annual profits with interest

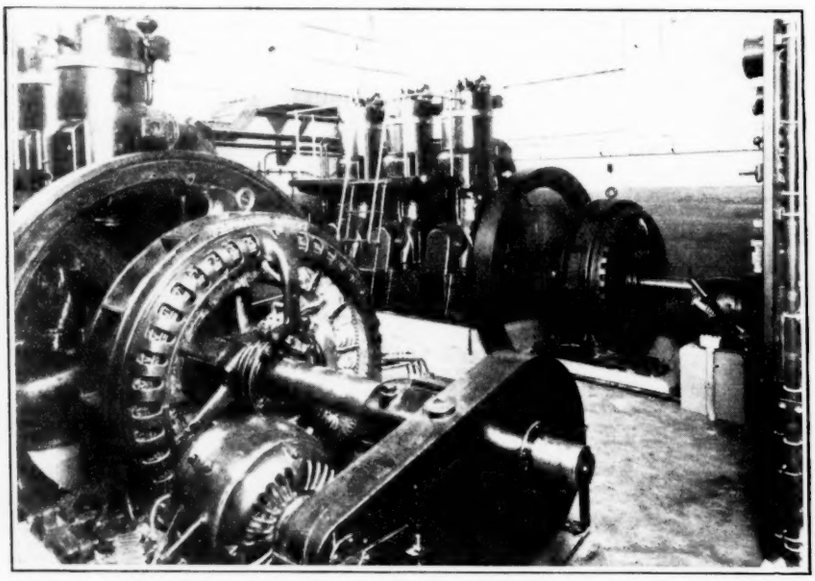


Fig. 2—The two 150-kva. Diesel generating units

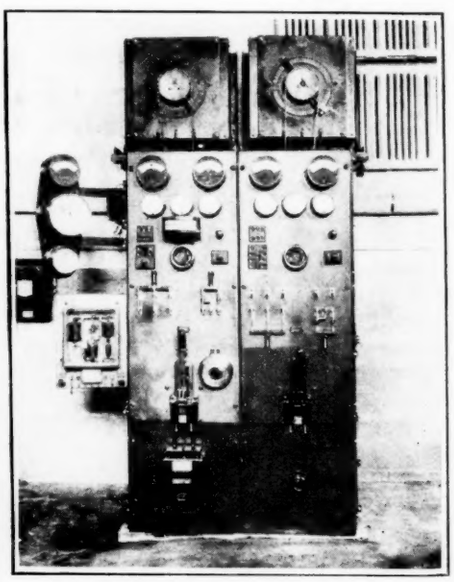


Fig. 3—Generator panels

added to the sinking fund and interest, would equal the total cost of the generating plant in a little over six years. After the plant had paid for itself, it was considered that the fixed charges should be disregarded in calculating the annual costs. Table II gives a comparison on this basis. It will be seen that the average yearly earnings of the generating plant, after seven years, are then $7,022.

TABLE I—SUMMARY OF ANNUAL COSTS IN TWO TYPES OF PLANT

	Per Cent
Depreciation giving 20-year life	5.00
Interest at 6 per cent, or average interest of	3.14
Maintenance	1.86
Total fixed charges	10.00

	Purchased Power Gasoline Engine Stand-by	Two Engine Generator Sets, one Serving as Stand-by
Total first cost of equipment	$11,500.00	$36,600.00
Cost of power or connection charge	7,970.00	0.00
Cost of fuel and lubricating oils	0.00	2,098.00
Fixed charges of 10 per cent	1,150.00	3,660.00
Labor (as in engineer's report)	4,400.00	4,400.00
	$13,520.00	$10,158.00

Advantage of generating plant per year: $13,520 — $10,158 = $3,362.

TABLE II—COMPARISON OF ANNUAL COSTS AFTER GENERATING PLANT HAS PAID FOR ITSELF OUT OF EARNINGS

Items	Purchased Power Gasoline Engine Stand-by	Two Engine Generator Sets, One as Stand-by
Cost of power or connected charge	$7,970.00	$ 0.00
Cost of fuel and lubricating oils	0.00	2,098.00
Fixed charges	1,150.00	0.00
Labor	4,400.00	4,400.00
Total annual costs	$13,520.00	$6,498.00

Yearly earnings of generating plant after 7 years = $13,520 − $6,498 = $7,022

As a result, it was decided to install the Diesel electric station with motor-driven pumps, the equipment throughout being furnished by Fairbanks, Morse & Co.

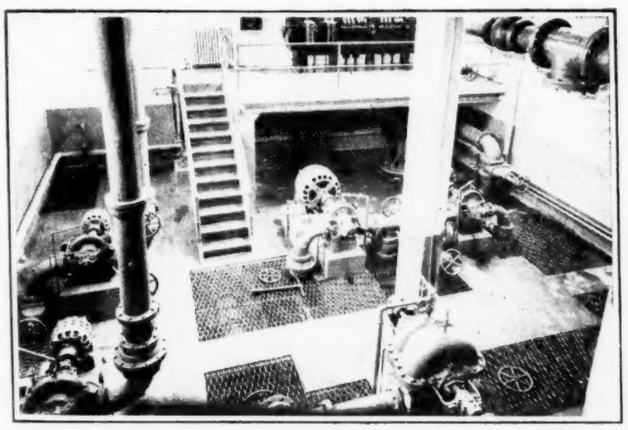


Fig. 4—Motor-driven pumping equipment

The modern brick and concrete building housing the pumping and filtration plant is shown in Fig. 1. It is in the middle of an area of some four square blocks, which is being converted rapidly into a city park. The low wing at the right is the engine room and the crib on the outer wall, the air intake. The structure partly shown at the extreme right houses the fuel-oil storage tank and communicates with the engine room by a tunnel.

In Fig. 2 are shown the two generating units, consisting of 180-hp. three-cylinder, vertical Diesel engines directly connected to 150-kva. 440-volt three-phase 60-cycle alternators complete with chain-driven exciters and the generator panels shown in Fig. 3. This size of unit makes it possible to carry the entire pumping load, even in the summer months, on one unit, while the other remains idle as a stand-by.

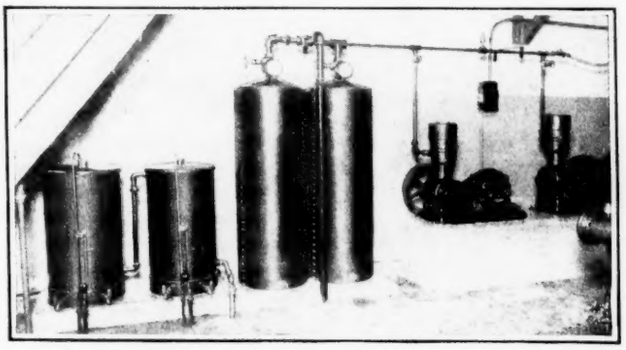


Fig. 5—Oil filters, air tanks and compressors

With the average load approximating 50 kw. and each unit rated to deliver 120 kw. at 80 per cent power factor, the generating capacity may be considered excessive. It should be explained that at the time the generating units were selected, additional load in the form of a railway pumping job and the white way lighting system, was anticipated. Eventually, the plant may supply these services, but for the time being the white way lighting is tied up under contract with the public utility.

Under existing conditions one set of pumps gives a load factor of 40 per cent on one unit, and the two sets of pumps, required during the summer, double the foregoing figure and, as previously stated, leave one unit idle as a stand-by. This is a good healthy condition, with plenty of reserve capacity to care for a growing load without additional expenditure in generating equipment.

With a population of 6,000, the present average daily requirement is around 900,000 gal. One of the engines is required to run about 17 hours a day, there being standpipe capacity sufficient for the night requirements. The current from the main bus on the generator panels in the engine room is conducted through underfloor

TABLE III—FUEL AND LUBRICATING OIL COSTS, PORTAGE PUMPING PLANT

Date	Engine No.	Hours of Pumping	Gallons of Fuel Oil Consumed	Kw.-Hr. Generated at Switchboard	Gallons of Water Pumped	Kw.-Hr. at Switchboard per 1,000 Gal. Pumped	Cost of Fuel and Lubricating Oil per 1,000 Gal. Water Pumped	Cost of Fuel and Lubricating Oil per Kw.-Hr. at Switchboard
May 15	2	15.2	110	984	987,400	0.995	$0.00761	$0.00765
May 16	2	10.4	62	600	632,000	0.95	0.00684	0.0072
May 17	1	9.3	68	648	636,800	1.02	0.0072	0.00706
May 18	1	16.3	125	1,236	1,254,000	0.985	0.00686	0.00697
May 19	1	18.9	137	1,380	1,400,000	0.985	0.00677	0.00688
May 20	2	19.1	133	1,416	1,430,000	0.99	0.00643	0.0065
May 23	1	12.6	97	876	909,600	0.965	0.0075	0.00778
					Average	0.985	0.00703	0.00715

Sample calculations for May 15: Cost of fuel oil, $0.062 per gal.; cost of lubricating oil, $0.612 per gal. Lubricating oil costs are based on 2,000 rated hp.-hr. per gal.

Cost of fuel oil per 1,000 gal. of water pumped = 110 ÷ (987.4 × 0.062) = $0.0069.

Cost of lub. oil per 1,000 gal. of water pumped = $\frac{15.2 \times 150 \text{ hp.}}{2{,}000 \times 987.4} \times 0.612 = 0.00071$

Total $0.00761

Cost of fuel oil and lub. oil per kw.-hr. = $\frac{0.00761}{0.995} = \$0.00765$

conduits to the starting and feeder panels mounted on the elevated platform in the pumproom shown in Fig. 4.

The water supply is obtained from the Wisconsin River through a concrete crib and a 16-in. submerged cast-iron pipe line about 900 ft. long connecting to a suction well just outside the filter plant. Two low-lift pumps of 750 gal. per min. capacity against 29 ft. dynamic head, draw the water from the suction well and discharge it into the mixing basin of the filter plant. Each pump is directly driven by a 7½-hp. motor. In the mixing basin alum is added to the water and thoroughly mixed by mechanical agitation before the water is passed along to the coagulating basins. Here the alum coagulates around the impurities and drags them to the bottom.

Filtering Process

From the upper level of this basin the water is drawn off and conducted to any one of three filter tanks, in which it passes down through 30 in. of sand and 18 in. of graded gravel to a perforated pipe underdrain system. A collector pipe conveys the water through an automatic rate control into the filtered-water reservoir from which the high-lift pumps draw their supply. There are three of these pumps, two with 4-in. discharge and 750 gal. per min. capacity against a total head of 150 ft. and one 6-in. pump of 1,000 gal. per min. capacity against a head of 158 ft. Each of the three pumps is directly connected to a squirrel-cage induction motor.

Another motor-driven 6-in. pump is provided to clean the filters by flushing large volumes of filtered water up through the sand to carry the accumulated impurities into the sewer. As it enters the clear well, the filtered water is chlorinated to remove any final traces of pathological bacteria that might be present.

By May 1 of the present year the complete installation was finished and since that time has been giving exceptionally good service. The contract for the mechanical equipment set forth regular fuel-oil and lubricating-oil guarantees and also stipulated that the cost for fuel and lubricating oils, with these commodities at 6 and 60c. per gallon delivered, respectively, was not to exceed 1½c. per 1,000 gal. of water pumped. Pump and motor efficiency guarantees also were called for and a guarantee that one engine would pull the entire pumping plant load when two high-lift and two low-lift pumps were operating simultaneously.

Official Tests

A disinterested engineer was obtained to guard the city's interest during the ten days' official tests on the check-up of these guarantees. Prof. G. L. Larsen, of the engineering department of the University of Wisconsin, was selected for this service. His report shows that the fuel consumption per brake horsepower-hour at full load was 0.44 lb. in one case and 0.415 lb. for the other engine. The grade of fuel oil used ranged from 32 to 36 deg. Baumé and cost delivered 6.2c. per gallon.

Data derived from seven days of this test as given in Table III, show an average cost per kilowatt-hour at the switchboard for fuel and lubricating oils of 0.765c. Per thousand gallons of water pumped, the fuel oil costs 0.69c. and the lubricating oil 0.071c., giving an aggregate cost for these two items of 0.761c. per kw.-hr. This figure is approximately one-half of the guaranteed cost of 1½c. per 1,000 gal. pumped.

Distillation of Lignite

The distillation of lignite for the production of oils and gasoline is the subject of an extended article in *Le Génie Civil* for Oct. 17, 1925. The work described has been developed in Italy to a considerable extent. Large-scale operations began in September, 1920.

Lignite in its natural state is an inferior fuel, not readily transported and used with difficulty even at the place of origin. It has, however, the great advantage of giving by distillation and catalytic treatment oils having the same quality as petroleum products.

Lignite varies widely. On the one hand is a low-grade woody material carrying over 50 per cent of water, which, when carbonized, leaves a residue that differs little from powdered charcoal and may be briquetted for domestic use. On the other hand is a fuel that might be classed as a sub-bituminous coal, with a water content of only 3 or 4 per cent. This is satisfactory for the manufacture of illuminating gas and yields metallurgical coke. In some cases the residual coke has too high ash content to permit its use in ordinary furnaces, but such coke may be gasified in special producers. This has been done at several places in Italy.

Many tests have shown that low-temperature distillation is not accomplished by simply heating any sort of apparatus to a relatively low temperature. Special study has been given to factors influencing the increased yield of byproducts and to the development of economical methods of heating. Low-temperature distillation (900 to 1,100 deg. F.) does not altogether avoid the decomposition of oils and volatile products, but this decomposition can be reduced by eliminating empty space in the furnace, particularly in the upper part at the charging point, where the gas remains a certain time and may be superheated and decomposed. From this point of view rotary furnaces are at a disadvantage because of the large empty space occupied by products of distillation.

The most important point in the design of a distillation furnace, apart from laboratory tests, is the economical industrial heating of the furnace. In a general way, it may be stated that if the distillation apparatus does not permit heating with the aid of its own gas produced by distillation, economic results become almost impossible. Heating solely at low temperature is essentially uneconomic, since on the one hand the efficiency of the furnace is low, and on the other hand the manner of heating does not permit the recovery of all the gas available from the lignite. One thus arrives at the conclusion that the furnace must not only realize slow and progressive distillation at low temperature for the product being recovered, but that the heating must finally be completed at a much higher temperature, permitting not only the recovery of all the gas and byproducts, but above all, a more rational and economic heating.

The article continues with a detailed description of two distillation plants, one for low-grade woody lignite with high moisture content, the other for high-grade lignite with low moisture content. The furnaces used are of the vertical type some 50 ft. high, the lignite passing downward slowly and continuously. The products of distillation are drawn off as formed, through offtakes that penetrate the entire bed of material. The furnaces are, of course, supplemented by condensers, tar extractors and reservoirs, scrubbing towers, etc.

The Purchase of Coal on Specification

By CHARLES E. COLBORN

COAL should be purchased with an eye to using it in existing furnaces without experimenting. Rigid specifications will exclude slate, dirty coal and excessive slack.

ONE of the results of the recent depression in the bituminous coal industry is a noticeable improvement as a whole in the coal quality. More attention is being paid by the mining companies to the production of clean coal. Many other firms are bidding on and welcoming inquiries for coal to be furnished on a specification basis to the consuming industries.

Purchasing by specification will assure a supply of coal of uniform grade and suitability for the purpose required and afford a means of adjusting the coal bill according to the value of the product received. It is hard to understand why, in the coal industry, this process should have been so stubbornly fought and so widely disregarded, since it is a basic law of the industries that the value of any product varies in proportion to its usability or utility.

Any coal as at present marketed, without regard to its composition, can be burned on modern stokers once they are arranged to use it. The process of arranging may take weeks or months and may involve the expenditure of large sums of money. Having once found out how to burn the coal that is available, is it not justifiable insurance against further experiment to lay down specifications governing the purchase of this coal?

Variation in Coal

In one plant which, having only a coal consumption of around 10 tons daily, purchased its fuel on the open market, it was found possible by closer attention to firing methods to make a considerable reduction in the coal cost per unit of output. After a short period with this improved operation, although the coal was still purchased from the same mine and dealer, troubles again cropped up. It was necessary to go through a large amount of research before it became evident that the coal as then furnished contained a larger percentage of fines than formerly. An investigation at the mine developed the fact that the dealer was mining pillars that, having been under squeeze, gave almost all slack coal. The owners of this plant, who had thought they were assured of good and suitable coal by using the output of one mine, thus found that they had faced a considerable loss through lack of an adequate understanding as to just what coal was wanted and would be furnished.

In another and larger plant, using around 100,000 tons yearly, the coal is bought under what appeared to be an advantageous contract at the time it was drawn up, assuring against price fluctuations for a number of years and allowing for the use of the entire production of one mine. After a few years of operation at this plant and mine, the sulphur, ash and fines percentages have all increased greatly and the plant under its own contract is left holding the bag, so to speak.

Ash and Sulphur Need Attention

In the preparation of specifications for the purchase of coal the item usually looked after is the heating value. Moisture is also mentioned in many cases and ash and sulphur in a few. Run-of-mine coal is bought by this name and no other designation. More attention deserves to be given to the items of sulphur and ash and fineness and less to moisture. In the matter of sulphur one pound of sulphur burned to SO_2 gives up in the process about 4,050 B.t.u., while one pound of carbon burned to CO_2 gives up around 14,600 B.t.u.

In buying coal at a stated tonnage price, we are paying a uniform price for equal weights of either sulphur or carbon, one of which is worth only one-third as much as the other. This is manifestly not in accord with economical practices. The mine operator, when objection is made, usually explains that it is impossible to control the sulphur in the coal, that it must be mined as deposited and that the nature of the particular deposit is such that the sulphur percentage is as found. This is, on the face of it, a logical explanation, and it is only through a knowledge of mining methods and results that its fallacy can be proved.

In a certain soft-coal mining district in which the writer happened to be employed after the war, was one large mine which ran through the entire hard times by reason of the low-sulphur coke that its coal made. At times word would come out from the main office that the sulphur was getting too high. The mine boss would pass the word along and always the sulphur came down again. No changes were made in the method or location of mining, just a little more care was exercised on the loaders' part. They realized that it profited them to be careful. There is undoubtedly a minimum below which it is not economically gainful to go, but in the majority of cases this minimum is a long way from actual practice.

Roof Coal

Ash in coal appears in two forms. One is as small particles intermixed with the combustible elements themselves, which as such are practically impossible of control or separation. The other is in the familiar slate, or more often found boney or roof coal. Most mine operators allow a foot or so of the roof to remain when the coal is worked out. Some of the smaller operations work closer than this, and in some regions where the top covering is sandstone, the entire seam is taken out. This roof coal cannot be readily detected as mined and so passes the pickers and is accepted by the buyer.

The boney and slate bands, however, can be readily detected and as far as possible are usually picked out in the mines. In the smaller mines, which often furnish the bulk of coal for industry, the loaders are supposed to remove these bands as they load the coal, the coal being chuted directly into cars as it is brought to the surface. The method of wage payment is inherently such as to discourage such slate separation. The miner is paid either tonnage or volume delivered prices, and time spent in the removal of refuse is time wasted from his point of view. In a small number of mines special effort is made to remove slate as mined, sufficient wages being paid for each car of slate removed to make it attractive for the miner to attend to this matter. The only practical solution apparent for ash control is in the more careful loading of the coal and the picking of it after hoisting.

Why Buy Water?

It is necessary to mine the wet places as well as the dry ones, and the moisture content of the coal is not susceptible to control. In mines using skip hoists and spraying the coal at the shaft bottoms as dumped, to keep down dust, it is possible to increase the moisture content about 1 per cent by copious spraying. The loss in heating value through the increase of 2 to 3 per cent in moisture content of coal is roughly around ½ per cent, which is not an excessive amount. However, a loss there is and some provision should be made to allow for it in the purchase.

A fourth item to which little attention is paid is the fineness factor, or amount of fine coal per unit weight of run of mine. In plants using screened coal or ¾-in. size, this is not a factor worthy of much attention, but in those stations using straight run-of-mine coal, it is a real issue. Bituminous coal as mined will contain a minimum of 17 per cent of slack or coal under ¾-in. This is due to the slack formed by the cutting machine in the mining. By proper shooting down of the coal after cutting, the total amount of slack should be kept under 30 per cent without any trouble. Also by improper placing and loading of shot holes, it is possible to run this percentage to a very high value. At one mine coming under observation, it runs at times as high as 50 per cent, as far as can be judged by observation. At another mine, which is mining a similar coal but by different methods, roughly 20 per cent is slack. This low percentage is in great measure due to considerable research that has been conducted at this mine into the methods of shooting down the coal to reduce the slack. It has been convincingly demonstrated that it is possible to control the slack through a range of 6 per cent of the coal mined, by correct methods of shooting. It would seem, therefore, that as this knowledge must soon become known throughout the coal industry generally, some mention should be made in specifications as to the fineness factor of the coal furnished.

Watch the Slack

The effects of excess slack are mainly in the increase in siftings, where underfeed stokers are used and in the changed fuel-bed contours with practically all kinds of stoking mechanisms. It is disconcerting after having made adjustments and trained operators in the maintaining of efficient fuel-bed conditions with a certain coal and stoker, to be compelled to start all over again by a large change in the coal size. In those plants whose coal-handling apparatus is not arranged to screen out the slack and bypass it around the crusher, crushing increases the fines in the coal to the bunkers. A simple method of testing coal for slack content is by sifting a sample through an ordinary ¾-in. coke fork. However, care must be used in getting a representative sample, which should be in the neighborhood of 600 to 1,000 lb.

There are very few coals that can be successfully burned on the commercial stokers of today unless these stokers are adapted to the characteristics of the coal handled after their installation. Commercially, it is not practical to especially design every stoker installation. If such engineering were resorted to, the costs of manufacture would be prohibitive. For this reason and for certain others, the stoker manufacturers tend to standardize each type of stoker and to trust to field adjustments to fit it to the immediate job in hand.

Every type of coal demands different treatment, and this treatment is ordinarily only possible of determination through experiment. It is under the conditions of experiment that the specification purchase is most often abused. Coal of a certain analysis and heat content is specified and bought for a job. The mine owner furnishes coal as agreed, and the purchasing agent feels content with consciousness of a job well done. The manager checks the coal analysis against the contract, pays his bonus or collects his penalties, and everyone is content but the engineer who has to burn the coal.

The act of putting a coal into the stoker hopper regardless of its quality, does not insure firing efficiency. In the experimental work, then, it would be much better to try the various coals available, find the one best suited to the stoker installation, learn to burn it successfully and then draw up specifications to insure its supply in the future.

There are occasions when the seizing of an oil engine can be traced to a hot piston pin, and ordinarily this is noticeable on starting the engine. After an engine has been in operation for some minutes, the heat absorbed by the piston is equaled by the heat given off by the piston to the cylinder walls, etc. The heat contained in the piston when the engine is shut down is large, and if the flow of cooling water is discontinued at once, a large part of this heat is absorbed by the piston pin. The pin elongates as a result of this heat absorption, and the end thrust of the pin produces a change in the shape of the piston walls; especially is this true when the walls are not strongly ribbed. The pressure exerted in the piston wall forces it against the cylinder wall and squeezing out the lubricating oil causes the piston to "freeze" to the cylinder.

Difficulty in pumping hot water is the result of overlooking one or more factors necessary to insure satisfaction. The main thing to bear in mind is that the hot water must follow the pump piston under gravity head, and to insure this the following points should be borne in mind: Place the pump below the heater or hot-water tank level; run ample size piping, slope the piping toward the pump, avoiding air pockets; eliminate all unnecessary valves and fittings in the supply line; use larger-sized pump for hot water than for cold; keep piston speed below 50 ft. per min.; use first-class metal or composition pump valves; reduce tension on valve springs until just sufficient to close the valves; if necessary, place a standpipe near the pump.

The Supply of Industrial Power*

By WILLIAM HARRISON LARKIN, Jr.†

THIS paper is intended as a message to power users and factory managers, with the thought that it may aid them in differentiating between good power-plant operation and inefficient work, help them to a better understanding of their engine and boiler rooms, assist them in getting maximum efficiency out of present plants, and indicate the course to be taken when it comes to enlargement or replacement.

THIS paper is a study of what is often the largest item of factory expense; that is, the power plant. It is an attempt to let light into a corner shrouded with mystery for the office man and something often considered too technical a matter for much factory supervision and control. The examination of an industrial power plant should be based on four principles: The question of its suitability, the possibility of future enlargement, its proper and economical operation, and finally, the availability of correct and continuous operating data and cost figures.

If the power requirements are small, the modern internal-combustion engine or a motor driven by central-station electric power may best meet the needs of the factory. Should the heating load be considerable, the steam engine with available exhaust would probably be more economical. When there is a large demand for process steam the modern high-back-pressure turbine or perhaps the bleeder-type turbine may prove best.

The question of suitabie boilers and fuel is important. Hand-fired boilers operated at low ratings are usually inefficient and can be replaced to advantage by modern water-tube boilers operated at higher ratings and better efficiencies.

Coal purchased may be cheap, but if transportation is high it often proves to be comparatively expensive. In New England, for instance, the higher-priced and better grades of coal usually generate more steam per dollar than the cheaper grades.

A well-considered power-plant program must contemplate enlargement. Many industrial plants are poorly laid out, are piecemeal growths of many years where expediency for the moment was considered above all else. Consolidation and electrification in such cases will usually pay satisfactory returns on investment and substitute an economical plan of future operation and enlargement for a haphazard method of generating power.

The day of the old-fashioned engineer who knew very little of theory and cared less, is long past. The cost of fuel is too high for indifferent or careless operation, and inefficiency has too great an effect on the cost of production to pass unnoticed.

No power department is well operated which does not produce regular and understandable data on power-operating efficiencies and costs that can be compared from month to month with records of similar plants. Operators should be made to realize that 60 per cent boiler efficiency is poor, that costs per thousand pounds of steam generated, per engine horsepower, or per kilowatt-hour will be carefully checked by the hand that controls the salary list.

Operating Costs

Table I gives comparative unit costs carefully compiled for the year 1924 from several factory power plants located in different parts of the country. The selection was made to show plants of varied character and sizes.

In all cases the public-service unit costs are made up of the cost per kilowatt-hour at the bus plus an operating charge which averages around 33 per cent. This operating expense covers the charges on the investment, operators' wages, and repairs and maintenance of substation, feeders, and motors.

Economy of Operation

Unfortunately, the matter of power-plant supervision is often considered too technical for control except in a very general way. The operating engineer receives very little attention in many industries, and indifference, poor operating efficiency and high costs often result. Many smaller power plants run along in ways that were obsolete years since, and many factories with fine buildings and excellent machinery shelter power plants with scaled-up boilers, tubes covered with soot, leaky furnaces, broken baffles, engines with valve gear out of adjustment, hot returns thrown overboard, and similar losses which run on because of the lack of a little understanding and supervision from the office. No modern factory can afford to be without the instruments that indicate what is going on in the power plant and that will turn their messages of character of daily operation into the office continuously.

If no attention is paid to the matter of feed-water treatment and boiler scale, it will be found expensive. Many a boiler steams along with an eighth or a quarter of an inch of scale on its tubes, using perhaps 25 per cent more coal than is necessary.

If firebrick in furnace walls are neglected, the result may be an entire new setting at large expense.

An economical operating engineer will see that a regular schedule of boiler inspection and cleaning is carried out. He will arrange to have boilers off the line at stated intervals, and while he looks after the details of the work, will expect a certain amount of supervision.

The lubrication of shafting and engines and the reduction of friction load are all matters that can receive attention with profit.

Turbines with eroded and broken blades, condenser

*Abstract of paper presented at the annual meeting of the A.S.M.E. in New York City, December, 1925.

†Power engineer, general division, United States Rubber Company.

air leaks, reduced speed, poor power factor and wet or improper steam supply build up expense and coal consumption imperceptibly but rapidly. These things cannot be detected on the instant, but regular observation of power records, frequent visits to the power plant, occasional judicious questions and an interest in the power machinery will pay large returns in the long run.

Power-Plant Operating Records

Continuous operating efficiency cannot be obtained from the power plant without some definite system of recording performance and costs. Special tests and reports by consulting engineers have their value, but more necessary is some regular and continuous method of reporting data that will give a definite relationship between performance and cost which can be compared from month to month with outside sources of information. Such a report should give the ratio between cost of power and pounds or quantity of goods produced. It should contain such units as the cost of steam per thousand pounds, evaporation per pound of fuel, engine power per horsepower-hour, electric power per kilowatt-hour, etc. Enough operating data should be recorded so that the report can be checked. With a series of such reports, perhaps covering performance for several years, information will be available that will show whether the power department is forging ahead or losing ground in operating efficiency. Faced with the necessity for enlarged capacity, replacement of obsolete units, or the possibility of turning to purchased electric power, the management has operating costs and data that will help determine the course. Any association of power-plant engineers, to derive maximum benefit from their meetings, must have some comprehensive form of continuous power report which will allow comparison of performance data and costs.

Industrial companies operating several plants have found it advantageous and necessary to inaugurate monthly power reports for the reasons mentioned. One corporation operating several plants located in various parts of the country has used such a system of reports with beneficial results for several years. The form of report is shown as Table II. Such a system of continuous power reports will save thousands of dollars annually, and few plants are too small for something of the kind.

The details of a monthly power report like that shown are readily understandable and little explanation is required. It is intended to be complete enough

TABLE I—COMPARATIVE DATA ON COST OF PURCHASED AND HOME-MADE POWER FOR PLANTS IN VARIOUS DISTRICTS

	Location	Average Number Employees Prod. and Non-Prod.	Kind of Power Used	Annual Total Equivalent Kw.-Hr.	Total Cost Power (Boilers Not Included)	Cost per Equivalent Kw.-Hr.	Estimated Cost All On Pub. Service Power	Unit Costs for Power 1924				
								Steam per 1,000 Lb.	Engine Power Hp.-Hr.	Generated Power Kw.-Hr.	Water Power Hp.-Hr.	Public Service Kw.-Hr.
	Central Group											
1	Indiana	368	Engine 20 per cent, Wat. Pow. 14 per cent, Gen. Electric 66 per cent.	11,892,211	119,512.42	0.01005	0.01686	0.316	0.0115	0.00885	0.0066	.....
2	Ohio	1203	Engine 5 per cent, Pub. Serv. Elect. 95 per cent.	7,013,395	143,724.91	0.0205	.....	0.327	0.0417	.....	.....	0.01922
3	Illinois	381	Engine 19 per cent, Pub. Serv. Elect. 81 per cent.	2,876,500	75,522.96	0.02625	.....	0.4929	0.03	.....	.....	0.0229
4	Michigan	3985	Engine 6 per cent, Gen. Elect. 66 per cent, Pub. Serv. Elect. 28 per cent.	33,530,767	380,524.72	0.01136	0.0145	0.378	0.0111	0.00994	.....	0.01453
5	Indiana	1032	Engine 23 per cent, Pub. Serv. Elect. 77 per cent.	5,155,372	94,096.23	0.01825	0.017	0.3843	0.0153	.....	.....	0.0177
6	Maryland	....	Gen. Electric 100 per cent.	11,491,000	38,725.00	.....	.....	.....	.....	0.00437	.....	.....
7	Pennsylvania	....	Gen. Electric 100 per cent.	8,518,000	44,464.00	.....	.....	.....	.....	0.00622	.....	.....
8	Louisiana	....	Gen. Electric 100 per cent.	9,598,000	40,983.00	.....	.....	.....	.....	0.00527	.....	.....
	N. Y. City Group											
9	New Jersey	1368	Engine 3 per cent, Pub. Serv. Electric 97 per cent.	8,019,000	227,695.20	0.0284	.....	0.462	0.0669	.....	.....	0.0253
10	Connecticut	328	Engine 50 per cent, Gen. Elect. 3 per cent, Pub. Serv. Elect. 47 per cent.	10,143,078	185,217.65	0.0183	0.01785	0.398	0.0143	0.0392	.....	0.0162
11	New Jersey	343	Engine 31 per cent, Gen. Elect. 5 per cent, Pub. Serv. Elect. 64 per cent.	420,447	23,339.03	0.0557	0.0426	0.609	0.0515	0.01695	.....	0.0403
	New England Group											
12	Massachusetts	1136	Engine 3 per cent, Pub. Serv. Elect. 97 per cent.	5,291,000	134,292.86	0.0254	.....	0.5940	0.0644	.....	.....	0.01755
13	Connecticut	300	Engine 41 per cent, Wat. Pow. 25 per cent, Gen. Elect. 13 per cent, Pub. Serv. 21 per cent.	1,697,466	54,488.67	0.0321	0.02668	0.5550	0.0288	0.025	0.02255	0.0272
14	Rhode Island	613	Engine 1 per cent, Pub. Serv. Elect. 99 per cent.	3,847,598	111,459.85	0.029	.....	0.5700	0.126	.....	.....	0.0264
15	Rhode Island	919	Engine 24 per cent, Pub. Serv. Elect. 76 per cent.	3,842,000	102,790.23	0.0267	0.0324	0.5260	0.0332	.....	.....	0.0214
16	Massachusetts	3150	Engine 80 per cent, Pub. Serv. Elect. 20 per cent.	2,601,023	.....	.....	0.0275	0.685	.....	0.0287	.....	0.0284
17	Massachusetts	285	Pub. Serv. Elect. 100 per cent	49,338	2,077.00	0.0421	0.0421	.....	.....	.....	.....	0.0421
18	Massachusetts	1050	Gen. Elect. 86 per cent, Pub. Serv. Elect. 14 per cent.	1,294,778	21,566.75	0.0167	0.022	0.5707	.....	0.0368	.....	0.0331
19	Connecticut	1543	Pub. Serv. Elect. 100 per cent	11,663,000	208,809.17	0.01792	.....	0.5741	.....	.....	.....	0.01792
20	Rhode Island	159	Engine 56 per cent, Gen. Elect. 4 per cent, Pub. Serv. Elect. 40 per cent.	1,071,778	31,279.92	0.0182	0.039	0.5420	0.0246	0.042	.....	0.0344
21	Massachusetts	3700	Pub. Serv. Elect. 100 per cent.	31,206,000	390,075.00	.....	0.0125	0.532	.....	.....	.....	0.0125
22	Massachusetts	....	Gen. Electric 100 per cent.	6,631,000	37,697.00	.....	0.01342	.....	.....	0.0067	.....	.....

NOTES—Seventh column—Cost per Equivalent Kilowatt-hour means cost of all classes of power as at present divided by the equivalent kilowatt-hours.
Last column—Unit Cost of Public Service Power includes Public Service bills, plant operation, repairs and maintenance of apparatus, feed lines, etc., depreciation and insurance charges. Usually equals public service charge plus 20 to 30 per cent (average).

to give a true picture of the operation as a whole, and is designed to be broad enough to cover plants with several classes of power apparatus and at the same time definite enough so that the unit costs, such as fire-room labor, for instance, can be compared with those of other plants.

The majority of industrial plants keep power records of some kind, but another phase of the matter is too often overlooked, namely, accuracy of data. Means for calibrating and checking instruments should always be provided.

The matter of coal testing is important. The operator needs to know that he is getting the most suitable fuel for the large amounts of money expended. All coal looks more or less alike, and the heat units contained in it cannot be seen. It is also important that the engineer know the thermal units in the coal that he may calculate his boiler efficiency correctly.

Where it is possible, valuable comparison can be made between a number of plants in the same system, or through co-operation between a number of plants in the same neighborhood or between the plants operated by the members of some association of plant engineers, as is not unusual. Such studies tend to increase operating efficiency, as it is often found that what was considered good operation will not bear comparison.

TABLE II—EXAMPLE OF A MONTHLY POWER REPORT

MONTHLY POWER REPORT

PLANT St. Jo
LOCATED INDIANA
MONTH JANUARY 1925

SECTION 1, GENERAL DATA

PRODUCTION DATA

1. Pounds of Goods Produced 2'109'033 — Pounds Raw Material Used
2. Total Coal Burned Bitum. 4023.7 — Per Ct. 100 — Cost Mine 1.50 — Frt. 1.56 — Handling .42 — Total 3.48 — B. T. U. 11'967
3. Total Coal Burned Anth. — Per Ct. — Cost Mine — Frt. — Handling — Total — B. T. U.
4. Total Oil Burned Bbls. — Specific Gravity — Cost Delivered — B. T. U.
5. Cost of all Power 25'256.62 — Same Less Charges 21'696.27
6. Cost of all Power from Accts. 19'826.48 — Total Man Hours, Productive 48'034
7. Cost of all Power per Pound Goods Produced .012 — Per Pound of Raw Material Used — Per Man Hour .526

OPERATING DATA

8. Factor of Evaporation 1.059 & 1.212 — Pounds Total Equivalent Evaporation 17'722'330
9. Temperature Outside Air, Average 19 — Average Barometer Reading
10. Temperature Flue Gas, Average 591 — Degrees Superheat, Average
11. Steam Pressure Gauge, Average 140 — Feed Temperature Fahr., Average 198
12. Temperature Water Entering Economizer, Average — Temperature Raw City Water, Average 50

FEED WATER DATA

Grains per Gal. Carbonates 10 — Sulphates 3.6 — Alkalinity Carried 42 — Chloride Carried 6.74
Chemicals Used for Treatment CAUSTIC SODA — Total Pounds for Month 6608 — 15 BAUME SOL.

SECTION 2, POWER PRODUCTION & TRANSMISSION DATA

POWER DATA	COST ITEMS	COST AMOUNTS: LABOR	Other than Labor	TOTAL	UNIT COSTS: Steam Per M Lbs. F. & A. 212°	
BOILERS						
A Average Boiler Load 3'288	1. Tot. Cost Boiler Fuel*	x x x	14025.40	14025.40	Fuel	.181
B Lbs. Evap. 73'392'191	2. Other Operat'g Exp.*	4073.40	111.84	4185.24	F. R. Labor	.052
C Evap. per 12000 B.T.U. 9.145	3. Boiler R'm Auxiliaries*	82.24	20.56	102.80	Supplies	.002
D Evap. per Lb. Fuel 9.12	4. Total Repairs	415.56	527.39	942.95	B. R. Aux.	.001
E Equiv. Evap. F. & A. 212° 9.66	5. Charges	x x x	1303.91	1303.91	Repairs	.012
F Boiler Efficiency 78.3	6. Total Cost	4571.20	15989.10	20560.30	Charges	.017
G Overall Efficiency 89.6					Total	.265
MAIN ENGINES	7. Cost of Steam Used	x x x	3348.91	3348.91	Main Engine	
H Average Load H. P. 985	8. Other Operat'g Exp.*	348.08	51.28	419.36	Power Per	
I Steam per H. P. Hour 21	9. Total Repairs	408.65	127.94	536.59	I. H. P. Hour	
J Total H. P. Hours 569'330	10. Charges	x x x	504.14	504.14	.00845	
	11. Total Cost	776.73	4032.27	4809.00		
AUXILIARY ENGINES	12. Cost of Steam Used	x x x	822.24	822.24	Auxiliary Engine	
K Average Load H. P. 164	13. Other Operat'g Exp.*	197.66	6.49	204.15	Power Per	
L Steam per H. P. Hour 24	14. Total Repairs	21.63	25.49	47.12	H. P. Hour	
M Total H. P. Hours 122'313	15. Charges	x x x	85.20	85.20	.00947	
	16. Total Cost	219.29	939.42	1158.71		
ELECTRIC GENERATORS	17. Cost of Steam Used	x x x	6236.77	6236.77	Generated	
N Average Output K. W. 1175	18. Other Operat'g Exp.*	219.45	43.62	263.07	Electric Power	
O Steam per K. W. Hour 25	19. Total Repairs	172.50	78.75	251.25	Per K. W. Hour	
P Total K. W. Hours 874'534	20. Charges	x x x	1122.87	1122.87	.009	
	21. Total Cost	391.95	7482.01	7873.96		
PURCHASED ELECT. POWER	22. Tot. Pub. Service Bills*	x x x			Purchased	
Q Average Load K. W.	23. Other Operat'g Exp.*				Electric Power	
R Total K. W. Hours	24. Total Repairs				Per K. W. Hour	
S Average Power Factor	25. Charges	x x x				
	26. Total Cost					
WATER POWER	27. Cost for Water*	x x x	340.54	340.54	Water Power	
T Average Load H. P. 184	28. Other Operat'g Exp.	285.92		285.92	Per H. P. Hour	
U Total H. P. Hours 110'626	29. Total Repairs	71.55	20.33	91.88		
V Hours Operated 601	30. Charges	x x x	544.23	544.23	.0114	
	31. Total Cost	357.47	905.10	1262.57		

SECTION 3

Distribution and Use of all Live Steam Generated in Thousands of Pounds for Month.

(a) Total Live Steam Used for Power	37'136	M Pounds
(b) Total Live Steam Used for Auxiliaries	3'669	M Pounds
(c) Total Live Steam Used for Heating	1'467	M Pounds
(d) Total Live Steam Used for Process Work	30'501	M Pounds
(e) Total Live Steam Used for Losses	619	M Pounds
(f) Total Live Steam Used (see Section 2, Item B)	73'392	M Pounds

NOTES—* Items marked with Star form Total Charge to Power Expense as per Form
Total Repairs and Maintenance Charges on this Report should balance with Amounts charged to Dept.

Signed Nathan S. Jessenden
Factory Manager

The power plants found in our mills and factories are changing in character rapidly. Twenty-five years back the fire-tube boiler and automatic engine were more or less universal. Today high-pressure water-tube boilers operated at high ratings are replacing the old horizontal-return-tubular boilers. Where the engine remains in the larger plants, it has been supplemented with the low-pressure exhaust turbine which generates electricity to drive the factory machinery not in the immediate vicinity of the engine room. Fre-

quently, the engine is superseded by the high-pressure turbo-generator whose low water rate and absence of friction load and transmission losses are found profitable. In many cases the boilers only remain to generate process and heating steam, while the motive power is provided by electricity from public-service stations, coming to the factory over high-tension lines and being stepped down to safe operating limits at the factory switchboard. Each factory has an ever-present problem to determine the most economical method.

The solution of the problem of most economical method of power generation must be approached with care, as changes usually mean considerable investment. Operating costs in detail should be available over a considerable period before extensive changes are contemplated. It must be ascertained first that the present power plant is being operated to the best advantage. Poor boiler operation results in high cost of steam and high cost for motive power per unit. An attractive figure from the public-service company may in effect be the comparison of their highly efficient operation with an unnecessarily poor grade of operation in the local plant. A favorable figure from the outside power company may result, for instance, from a lack of understanding at the factory of the value of the exhaust steam used for heating and process work. There are many cases where purchased power is the most economical way out, but there is no general rule and each case must stand on its merits. When the question of plant enlargement is under consideration, the matter of public-service power, if available, should have most careful attention, as then the factor of new investment is prominent. Then enlargement of prime movers will probably mean additional boiler capacity, enlarged steam mains, new coal-handling apparatus, and similar expense, which may result in an unfavorable unit cost.

Control of Elevator Brake Action

By William Zepernick

The mechanical construction of an alternating-current elevator brake is not necessarily different from that employed with direct current. The construction of the operating device when electrical will be materially different because of the difference in characteristics of the two currents. The control of the action of an alternating-current magnet is necessarily mechanical, being obtained through an oil dashpot in which the brake magnet is immersed. By this means the brake may be adjusted to permit inching the elevator; to permit a cushion effect when lifting, thus preventing noise; and to enable the brake to apply gradually when stopping. The oil in this type of brake serves a double purpose—that of dashpotting and conducting the heat away from the winding. The insulating qualities of this oil are good and afford additional protection to the winding.

The action of the direct-current brake can be governed by the use of a discharge resistance connected across the brake-magnet winding or in series with it. Advantage is taken of the fact that when a magnet is de-energized, a regenerative action takes place due to the collapsing magnetic field cutting across the conductors comprising the magnet coil. This field collapsing, induces a voltage in the coil winding which will cause a circulating current to flow through the coil and resistance connected in parallel with it. This current through the coil tends to prevent the brake being applied suddenly and stops the car without an unpleasant jerk.

There are various circuits utilized with the direct-current brake magnets. The smaller types of brake magnets for direct-current machines are likely to be connected directly across the line when releasing the brake shoes, and when applying the brake the coil is open-circuited without the use of parallel resistance for retarding the release. In this case the energy of the magnet is dissipated in the arc produced at the contact when opening. Parallel resistance alone is used at times on smaller types of machines to enable a gradual application of the brake shoes. The application of the brake is then fixed by the resistance of the circuit provided for the discharge current of the brake magnet.

A more flexible control of brake action is obtained with the use of series and parallel resistances. In this case a contact is provided upon the brake magnet which is opened as the brake lifts. Opening this contact causes resistance to be inserted in the brake-magnet circuit after the brake has lifted, thus decreasing the current in the winding to a value just sufficient for the magnet to hold the brake shoes clear of the wheel; at the same time the energy of the magnet is materially decreased, permitting a quick application of the brake if desired. By adjusting the parallel resistance, any desired brake application may be obtained. The circuit for the parallel resistance in this case is usually taken through two contacts. At either terminal landing one of these contacts is opened by the automatic stopping switch, and this permits a hard brake application at the limits of travel.

In discussing the use of pulverized coal, P. Nicholls, of the United States Bureau of Mines, stated that while powdering the coal would permit the use of lower grades and at the same time lead to higher efficiencies, efficiency of combustion is not the sole factor to be considered and time alone will demonstrate whether the over-all economy secured will be such as to permit of a large demand created for low-grade fuels. Even if equal efficiencies were attained, a number of factors increase the operating costs with low-grade pulverized fuels. Among these should be mentioned the freight and handling charges on the ash and moisture content, the extra power required for grinding, the heavier wear on all machinery, the expense of removing and disposing of large amounts of ash and the more rapid destruction of the refractories. Furthermore, although good efficiencies can be attained from low-grade fuels, the maximum capacities of the boilers are lower than with the better grades, and the possibility of trouble or stoppage will always be greater.

The National Fire Protection Association recommended that where oil engines are used with the exhaust pipe and muffler not water-jacketed, woodwork within 9 in. of these parts should be protected by ¼-in asbestos board covered with sheet metal. A dead-air space of ¼ in. should be left between the protecting asbestos and the wood, and a clearance of not less than one-third its diameter maintained between the pipe and the surface of such protection.

How To Obtain Service from Carbon Brushes

By W. C. KALB

General Manager, Corliss Carbon Company, Bradford, Pennsylvania

ATTENTION is directed to the difference in operating conditions in the older types and modern machine, under which brushes have to operate, and then suggestions are made as to how to apply brushes to get good service from them.

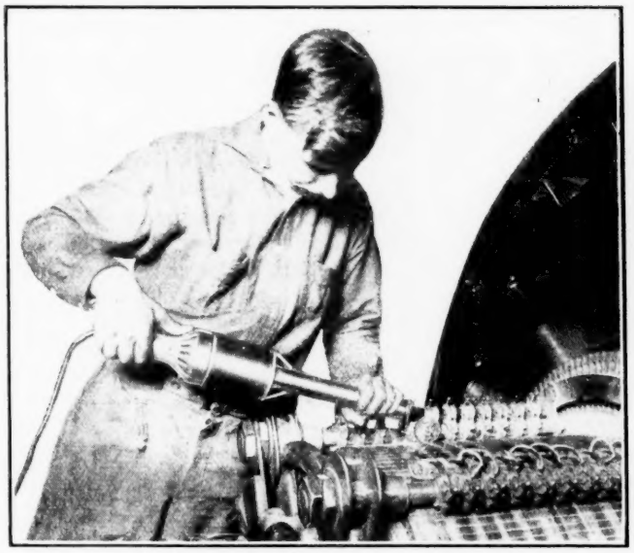


Fig. 1—Undercutting the mica in a commutator

THE question often arises as to the reason for the comparatively short life obtained with present-day expensive brushes on machines of modern design, when it is recalled that on old non-interpole machines with cheaper grades of brushes it was not uncommon to get brush life of six, eight or ten years. The statement is sometimes made that brushes manufactured today are not equal in quality to those of ten or fifteen years ago. As a matter of fact the brushes of today are greatly superior to the grades manufactured a decade ago, but are compelled to operate under conditions that preclude the possibility of the long life formerly obtained.

An analysis of the trend in machine design brought about by the keen competition in the electrical manufacturing field will disclose in what respects the demands made upon the brushes today are of greater severity than was formerly the case. The brushes that gave ten years' life on a generator built fifteen or twenty years ago would probably not be acceptable to any operator on a large generator or rotary of modern design.

In the older designs current densities were low, not only in the brush itself, but in the windings of the machines. Commutator speeds seldom exceeded 3,500 ft. per min. and were more commonly under 3,000. While the mica of the commutators was seldom undercut, the slow surface speed permitted the use of a slightly abrasive brush which took care of what mild tendency there might be toward high mica without undue friction loss, commutator wear, or a serious tendency toward chattering as a result of the higher friction coefficient of this type of brush.

The commutating zone on these older machines was wide, and in consequence they were not sensitive to changes in load. All dimensions were liberal, exposing large areas for the dispensation of heat. In short, the low temperature characteristic of these early designs was the secret of their highly satisfactory performance, but this characteristic was purchased at a price that cannot be paid today. Machine dimensions have been reduced, densities in both electrical and magnetic circuits increased, velocities, both angular and surface, raised until commutator surface speeds of more than a mile per minute are not uncommon.

Brush densities, which were formerly about 25 to 35 amperes per square inch, are now as high as 80 on standard power apparatus. Operating temperature may be expected to lie close to the upper permissible limit at rated load of the machine. Even with interpoles and compensating windings to maintain passable commutating conditions, with undercutting of the mica to remove the need for abrasiveness in the brush and permit the use of grades with lower coefficient of friction, and with improvements in methods of ventilation to offset the more compact design, machines of the present day demand much more of the brush than was the case a decade or two ago. Under these circumstances it is unreasonable to put upon the brush any burden beyond the satisfactory performance of the three inherent functions which it must necessarily perform when the machine is in operation.

What the Brushes Must Accomplish

The first of these functions is that of a load carrier. All direct-current motors and generators possess a rotating current-carrying element, and a conducting link must be provided between this element and the stationary external circuit. This is the primary function of the brushes.

The second function of the brushes results from the fact that this connecting link between the external circuit and the rotating element is of necessity a sliding contact, under whose face a commutator composed of numerous copper segments is revolving at a speed of several thousand feet per minute. Maintenance of firm and uninterrupted contact, with the minimum amount of friction and wear on the commutator are requisite to the successful performance of this second function.

Since the current generated in the coils of the rotating armature is alternating in direction, it must be rectified before passing to the external circuit. This is accomplished by means of a commutator which is noth-

ing more nor less than a pole-changing switch, which maintains constant direction of current in the external circuit by reversing the connections to each coil twice in each cycle of its revolution. At the moment of reversal of the connection the coil is short-circuited by the brush, and the reversal of the current in the coil itself must be completed during this interval of short-circuit.

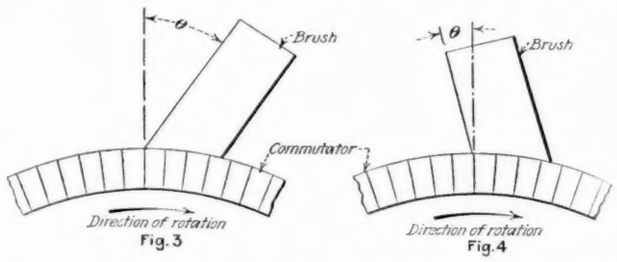
This reversal of current in the coil is resisted by self and mutual induction, with the result that a considerable voltage is established tending to maintain current in the original direction. The reactance voltage, as it is called, is to some extent neutralized by the introduction of a magnetic flux tending to assist in the reversal of the current. On non-interpole machines this flux is established by shifting the commutating zone into the influence of an adjacent pole tip, while on interpole machines it is accomplished by means of a series of windings on the interpoles without the necessity of displacing the brushes from the mechanical neutral. It is impracticable, however, to neutralize entirely the reactance voltage throughout the commutating interval, and a third function is thereby imposed upon the brush, namely, that of controlling the current generated by the resultant voltage in the short-circuited coil within limits that will not interfere with the satisfactory performance of the machine.

The three functions just described require certain definite characteristics in the brush that is to perform them. The first calls for high electrical conductivity through the major axis of the brush; the second, for low coefficient of friction, a minimum of abrasiveness, and ability to bear without chattering upon a rapidly revolving segmented cylinder; the third function demands resistance to short-circuit currents either in the

Fig. 2—Brushes must be properly fitted to the commutator

form of high resistance at the contact face or a high transverse resistance.

Considering the divergent character of these demands, it is unreasonable to expect the brush to fulfill any other function, yet here are a few of the added requirements frequently imposed: To carry extreme overloads; to carry full rated load when abnormal conditions exist, creating high temperature; to carry a full rated load with poor contact on the commutator due to high mica, vibration or spots or dirt; to run cool and quietly when the commutator has flat spots or high mica, when the brushes are set at an improper angle, held in loose holders or holders of poor design, or with the tension springs adjusted to unequal or incorrect pressure; to act as a grinding stone to remove high mica or inequalities in the commutator surface; to scour from the commutator surface the effect of burning resulting from poor commutating conditions; to give sparkless commutation when the fields are of unequal strength; air gaps unequal; brush studs unevenly spaced



Figs. 3 and 4—Show angle that brushes should make with the commutator

or improperly aligned; brushes set out of commutating position or interpoles improperly adjusted.

The foregoing unreasonable demands suggest their own corrections, but it may be well to list in positive manner the things to be done in order that the brushes may have a chance to function properly.

In order that the brushes may be able to carry successfully the load current of the machine, excessive overloads should be avoided. All possible sources of heating should be eliminated. The ventilating ducts of the machine should be cleaned regularly by blowing them out with a jet of air and by preventing the accumulation of oil or other material that might interfere with free circulation of air. The brushes should be kept free in the brush holders so that good contact with the commutator is insured. Shunt connections both at the brush and at the holder should be clean and firmly secured. The commutator surface should be true and carefully prepared.

Taking Care of the Commutator

In the preparation of the commutator surface it is well to remember that an uneven commutator cannot be given true cylindrical form by the use of sandpaper. In the case of extreme irregularities it may be necessary to use a steel turning tool. This has a tendency, however, to cut slightly deeper at one edge of the commutator segment than at the other, and should always be followed by a grinding operation. In grinding the commutator, whether in a lathe or in the machine bearings, the stone or wheel used for the purpose must be rigidly mounted, so that all possibility of radial movement is eliminated. In this manner a true cylindrical surface can be secured and all traces of former irregularities removed. Longitudinal feed during the final cut should be slow, in order to avoid any threading action on the commutator surface. Fine sandpaper mounted on a suitably curved block may then be used in giving the commutator surface a final polish.

In order that the brush may function properly as a sliding contact, undercutting of the mica is recommended wherever conditions will permit. This eliminates the necessity for using an abrasive brush except

in the most extreme cases. Where a tendency for spotting of the commutator still exists, it can sometimes be corrected on an undercut commutator by using a hard non-abrasive brush and the tendency toward unnecessary commutator wear thus be avoided. Firm contact can be maintained only if brush-holders are firmly mounted, tension evenly adjusted at a value suited to the grade of brush being used, and the angle suitable for the direction of rotation. Where rotation is against the sharper edge of the brush, the angle of inclination θ from the radial, Fig. 3, should be from 30 to 40 deg.; 37½ deg. is an angle very commonly used and one that experience has shown to be highly satisfactory. If rotation is against the obtuse angle of the brush, as in Fig. 4, excessive inclination results in a wedging action. It is better in this case for the angle θ of inclination not to exceed 20 deg., with 15 deg. representing the best position for average conditions. Worn brush-holders do not permit of firm contact and should be replaced or repaired. Likewise, the size of the brush requires observation, in order that free movement of the brush in the holder may be obtained without possibility of binding.

Conditions for Good Commutation

Good commutation demands primarily symmetrical magnetic conditions. This calls for checking and, if necessary, adjusting the strength of the main poles, the uniformity of the air gap, the spacing and alignment of the brush studs, the security of all connections. Brushes must not only be free in the brush holders, but must never be too loose, otherwise they may tip in the holder and throw the face off the neutral position on a sensitive machine. The location of the electrical neutral should be determined and the brushes accurately set at this point. In the case of interpole machines it is sometimes necessary to adjust the strength of the interpolar field, particularly when a decided change is made in the grade of brush used on the machine. High, low or loose commutator bars should, of course, be noted and corrected, as well as worn bearings, the latter being the most common source of unequal air gap.

With operating conditions established in accordance with the foregoing suggestions, the factor remaining to insure good service from brushes is the selection of a suitable grade. Practically all carbon manufacturers willingly lend the assistance of their engineering staff for this purpose, but where it is desired to make a selection from information given in the manufacturer's catalog, the following simple rules will be of assistance: First determine the current density by dividing the load current in amperes by the cross-sectional area of half the brushes on the machine. Select for consideration only those grades whose rated carrying capacity is equal to or greater than the calculated current density. Determine the peripheral speed of the commutator by multiplying its diameter in feet by 3 and by the revolutions per minute. Eliminate from consideration the grades previously selected which are not rated for commutator speeds equal to or greater than the calculated speed. These two steps will probably have reduced the grades under consideration to a comparatively small number, and selection from this small group can be made by considering the description of the grade with particular reference to its commutating characteristics and the classes of service for which it is particularly recommended.

Improvement in Gland Seals for Centrifugal Pumps

By J. C. Hobbs

THERE are in all probability more centrifugal pumps in use than any other type. In spite of this there are numerous beliefs as to operating characteristics, and even as to the proper way to seal the shaft bearings from leakage. The lack of exact appreciation of the conditions under which a gland operates is more widespread than is realized.

The packing glands are usually designed the same for both ends of the shaft, although the service is quite different, an exception being single-stage hydraulically balanced pumps.

The function of the packing gland on the pressure side of the pumps is to prevent leakage of water from

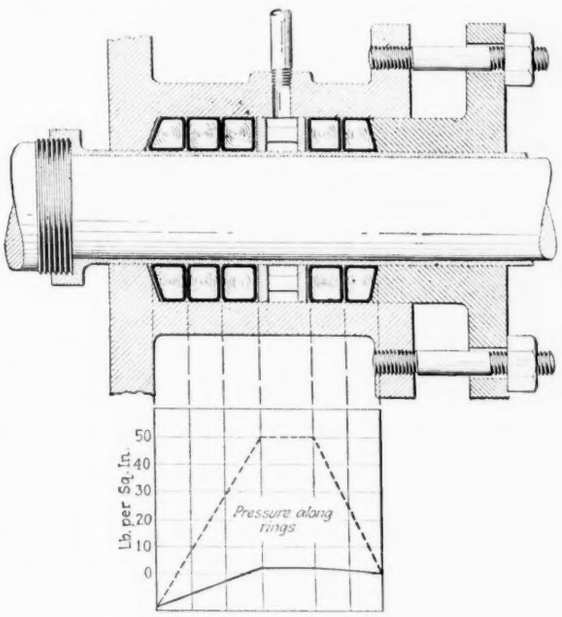


Fig. 1—Pressure on packing rings

the casing to the outside, whereas the function of the gland on the suction side is to prevent air leakage from the outside into the pump. When priming, both glands may be subject to the suction condition unless the liquid flows to the pumps under a head, in which case neither will ever leak air as a pressure is always present within the casing during the primary operation.

On the suction side of the pump there is a vacuum inside the casing, which decreases at each of the packing rings toward the outside, usually becoming a pressure at the lantern. This brings us to the most important point in the discussion.

The sealing water is usually delivered to the gland at a considerable pressure, sometimes being taken from the high-pressure mains and throttled through valves located just above each gland.

Pressure on the lantern must be sealed along the shaft by a limited number of packing rings, usually only two; these are on the outside. In order to reduce the leakage to a minimum, the gland bolts must be tightened until a considerable packing pressure is exerted against the shaft. When new the leakage is

small, but after the shaft or the sleeve wears it becomes increasingly difficult to maintain a tight gland. A new shaft or sleeve or the nuisance of a leaky gland are the only alternatives.

In Fig. 1 is shown a gland together with a chart giving the pressure exerted on each ring with a lantern pressure of 1 lb. and 50 lb.

Does the pressure seal the gland or is it the volume? Can air get in if the shaft is packed with a solid yet

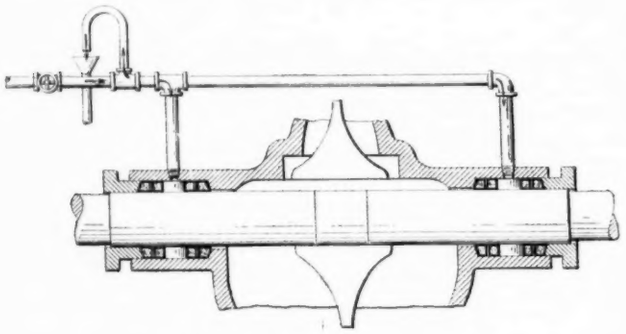


Fig. 2—Using low-pressure water

flexible and yielding ring of water? Does the increased pressure on the water make its sealing ability any greater? The answers are obvious. No air could leak in if the gland were submerged even under a few inches of water, which would exert only a few ounces of pressure.

What good does it do to have pressure? Some say that they have no pressure in the lantern because the supply is throttled. The objection to this is that the operator cannot determine how much to throttle so that the leakage will be provided for. If there is a pressure, the packing outside must be pulled too tight,

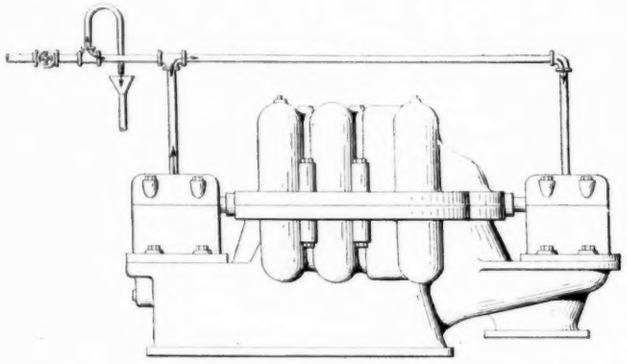


Fig. 3—Connecting high- and low-pressure glands

and if there is no water leakage and not enough water to fill the gland, air will leak through.

In Fig. 2 is shown an arrangement that has been used in many plants with great success for more than ten years. With such an arrangement the pressure is reduced so that the nuts on the glands can be turned with the fingers.

Less pressure on the glands means less wear on the shaft or sleeve and less power and less water for sealing. If high-pressure water is used, a small tank with a float control can be installed to obtain the desired low head. It goes without saying that the piping so often furnished with the pump connecting the glands with a pressure stage, should be removed and replaced with the low-pressure seal system.

Glands that do not have vacuum on them should have the lantern gland removed. If trouble is experienced in preventing leakage, the lantern can be used as a leak-off, the connection being piped back to the suction or some other point of low pressure. With an arrangement such as shown in Fig. 3, the gland on the high pressure side need be pulled up only tight enough to hold the reduced pressure. The leakage can be checked by shutting off the gland water and observing the flow at the overflow funnel.

Giving the packing a fair chance not only saves shaft sleeves but packing and much labor cost and loss of use of the pump while under repairs.

Leveling Up the Frame

If an engine is a horizontal center-crank one, it is usually possible to level it up by a spirit level placed on the main bearing housings. The top surfaces of the housings are usually machined parallel with the plane of the crank and cylinder center lines.

By placing the level parallel with the shaft line the frame can be trued up transversly, while placing it across the top of the two throws and parallel with the cylinder allows the discrepancy that exists longitudinally to be corrected. It is necessary to check the results by leveling both housings and rechecking the process. A few engines have a true surface machined on the top of the cylinder to facilitate the work of leveling.

Buckling, or bending of plates in storage batteries, is due to unequal expansion on the two surfaces of the plates. It is usually due to over-discharge of the whole or a portion of the plate. Patches of sulphate may hinder chemical action at these points, and expansion of the active material on the opposite side of the plate cause it to bend. Differences of temperature or the action of light may also cause bending. A buckled plate will not usually cause a short-circuit where there are wooden separators between plates, but it should be straightened if possible the next time the cell is overhauled. If very badly bent, it may be necessary to cut out the cell and repair it at once. The plate should be straightened by steady pressure between two boards, rather than the easier but less reliable method of striking with a mallet.

Although an oil-insulated, oil-cooled transformer is one of the most simple pieces of electrical equipment, it should not be expected to operate continuously after being put into service without attention. An inspection should be made once every six months at least. This should include a test of a sample of oil drawn from the bottom of the tank and a check on the temperature and load of the transformer.

The pull-out torque of an induction motor is the maximum torque that it will develop at normal voltage after being allowed to run up to normal speed; that is, the maximum torque of the motor will develop when loaded to a point where it stalls. The pull-out torque is from 2 to 3.5 times the full-load torque, depending upon the design of the motor.

A Letter from an Engineering Executive to His Son

THE following communication from a New England contributor to his son, on the occasion of the latter's embarking upon an engineering career, contains so much fundamentally sound advice that it is printed in full in the hope that its purpose may serve other young men similarly situated.—Editor.

MY DEAR MARSHALL:

Tomorrow you are to become an employee in one of the major industrial plants of the country, and I thought this an opportune moment to give you some advice, the results of some thirty years' experience in a similar plant.

First, as to your preparation for the job: You have been graduated with two degrees from the leading engineering school in the United States. Just what does this mean? It does not necessarily mean—note the word necessarily—that you are an engineer. It does mean, however, that you have spent five years at that institution and that you have completed in a manner satisfactory to the instructing staff the courses of study; and when the high standing of the school in educational matters is considered, this does mean that your work has been no child's play, but has required long hours of intensive application. It also means that you must have absorbed or retained a certain, and by no means inconsiderable, amount of engineering knowledge; otherwise you could not have successfully completed your course.

THE ENGINEER SHOULD ALWAYS BE A STUDENT

This period in your life which you have just completed, is commonly known as the student period. This in some respects is a wrong designation. In reality your student days are just beginning. You are now to become a student of real life, and the successful engineer forever continues to be a student. In your college days your problems were made to fit the student, they were bound to come out right, and the answers were usually to be found at the end of the book. The real problems that you are now to be called upon to solve have never been solved before; the answers are unknown. You must fit yourself to these problems. Some of them perhaps cannot be solved, but never admit that fact until you have exhausted every possible means of solution. In the various laboratories you have tested many samples both from a chemical and from an engineering viewpoint. You are now to test full-sized specimens, and in turn you are to be tested yourself. Do not overlook this last fact particularly. You are to be subjected to the acid test, the endurance test and the breaking-strength test. See to it that you withstand them all.

The main object of your studies has been to acquaint you with the natural laws governing all mathematical, engineering and chemical relations. You should have learned how best to approach the solution of a problem involving any of these relations. You are now to meet with these problems in real industry, and your education will have prepared you to work out their solutions in the quickest time and in the most efficient manner. Do not get the idea that the man who can carry the greatest number of formulas in his head is necessarily the most capable man, and that he who forgets them all is the least so. In my own class was an excellent instance of each of these types of men, but the man who could remember all the formulas never knew which one to use or how to use it, while the other fellow, although he could not carry them in his head, knew what formula to use, how to use it and where he could find it when he wanted it. Formulas are like tools; possession of them is of no value unless one knows how to use them.

PRACTICAL KNOWLEDGE MORE ESSENTIAL THAN SCIENTIFIC EDUCATION

Never boast or brag of your education, particularly before those who have been less fortunate. They are likely to resent it, and it does you no credit. It is better to have persons get this information concerning you from others than yourself. Lack of education, while a serious handicap, is no disgrace; and the working boy who, by years of denial and hard work daytimes and studying at night, obtains a scientific education, is far more deserving of credit than he whose education has been financed by his parents. As you get deeper into your work, you will find that theory, which has played such a large part in your student work, is not all—in fact it may be the lesser part by far. You will find that practical knowledge is all important and that in this line the working boy far excels in the beginning at least.

Your first day at the plant is all important. First impressions are likely to be lasting, and often has a man been forever handicapped by some misstep that he made the first day he met his new associates. Be careful of your appearance. No one but an out and out genius can afford to be slovenly in his dress, and such persons are rare these days. On the other hand, you must dress in keeping with your position and the nature of your work. It is not wise if you are engaged in work or surroundings that are dirty, to dress as if you were attending an afternoon reception.

PUNCTUALITY AN IMPORTANT FACTOR

Whatever be your hours of duty, see that you are punctual, if anything, a little ahead of time. Above all things do not be a clock watcher. Do not get the habit of leaving the plant before loosing time unless you have been told to do so. Your work and your interest in it should take precedence at all times; these should be your first and greatest considerations. There is one point, however, that you should bear in mind in this

connection. Regularity in eating is desirable for your health's sake. Non-observance of this point when long continued is likely to result unfortunately, and many a young man has thus laid the foundation of future ills. Occasions will arise when meals must be omitted or delayed, but regular irregularity in this respect is neither necessary nor desirable. The man who cannot so arrange his work that he can leave it at stated times is lacking in some phase of managerial ability.

You must place yourself and your services at the disposal of your employers night and day, Sundays and holidays, if such be required. It is often said, and it is true, that a man gets paid only for the services that he gives. Be sure that you give more than is required of you if possible. Do not concern yourself at this time about the remuneration; that will surely come later.

The Value of Promptness in Keeping Appointments

Be prompt in keeping appointments; and this applies not only to those made with your superiors, but also to those made with those who work under you. If you are late in keeping an appointment, you are delaying the game—to use a sporting term—you are keeping someone from his work. You would quickly condemn this lateness in others, and you must yourself set an example for those under you.

Much of the work will be new to you, in fact, practically all. Do not be afraid to show your ignorance. You will find that men will think the better of you and will be eager to teach you and give you any desired information. Be willing to learn from anyone and everyone, even the lowest-paid and most ignorant helper in the plant, if he has something worth while to impart. He may not be able to express himself in technical terms or elegant language, but as the result of doing the same thing day after day for a long period of time he may know all that there is to be known about his particular job. Often, when looking for information in this way, you may have to listen to much that is foreign to the matter in mind or to what you already know, but be patient and do not let your informant know of these facts.

Acknowledging Errors and Giving Credit for New Ideas and Processes

Do not feel above those under you or at least do not show that feeling; and it is better for the development of your character that you do not feel it. On the other hand, never so conduct yourself as to lose the respect that is due your position. There is the middle ground to be taken, and as a result the men will like and honor you the more. Always be quick to acknowledge your error and to take your share of any blame that should rightfully be yours. It is not criminal to make a mistake—the crime comes when the same mistake is made a second time. Whenever an error or accident happens in connection with your work, never rest content until you have found out the cause and the means of preventing it from recurring. Never fail to give credit for a new idea, a new process, a new tool or a new machine to whom it is due. Do not pass off as your own idea or your own work that of a man under you. You may get away with it, to use a slang phrase, but it will cheapen your character and your better nature will resent it.

Never censure an employee in public, that is, before his or her fellow employees. Reprimanding is much more efficient when done in private. Never order a man in your employ to do anything or go any place that you would not do or go yourself because of the danger involved. In case it is necessary for such work to be done, call for volunteers and have it plainly understood that the danger exists and that the service is voluntary. This releases you from any moral responsibility and also from a legal one.

Approach every problem or argument with an open mind, absolutely unprejudiced and unbiassed. Be thorough and exhaustive. If you are sent to obtain certain data, be sure that you cover every phase of the matter and obtain the requisite information concerning every detail. Such action demands study and forethought, but it is absolutely necessary to success. Develop the analytical mind and the all-seeing eye.

When you have written reports to make, see to it that they are intelligently, logically composed, and complete. Practice will accomplish much in this line, and do not get discouraged if first attempts are not all that they should be.

As you advance in your work, as I hope you will, do not so conduct your job that your plant or your department must close down if you are absent. Many executives have the idea that such a dependence is creditable to them, in that it proves how indispensable they are to the operation of the plant. They are greatly in error. Such action shows poor management and short-sightedness. Give the men under you proper responsibility in their work. If they are not capable of assuming this responsibility, then employ those who are capable.

Desks Should Be Kept Orderly

If you have a desk, see that the top at least is kept orderly and up to date. By this latter I mean do not have it cluttered with a mass of material that is not active. Use system in all things. Always carry a notebook of some kind in your pocket, in which to jot down the bit of information that you have picked up, the data to which you must refer or the work that you must get started.

Keep in close touch with the progress and development of that particular industry with which you are connected. Do this in part by subscribing to at least one technical magazine relating thereto, or if the company receives such magazine regularly, you can read those copies. Engineering science and industry are advancing rapidly and will gather even more speed in the next few years. The methods and reasonings of today will be superseded by those of tomorrow, and you must be up to the minute in order to achieve success. Keep a reference file of magazine clippings such as you may consider worth retaining. You will often find this useful.

Promises, Once Made, Should Be Kept

In making promises to complete a job at a determined time, make the time later rather than earlier than what you think you can do it in. That is, it is far better to finish the work in a shorter time than promised than to require a longer time. The first goes to your credit, the second is marked against you. But having once made your promise, do everything in your power to make good that promise. The same principle applies in estimating the cost of a job. It is better to overestimate than to underestimate.

In closing I can do no better than to urge you to

be efficient, at the same time recalling to your mind the summing-up by Dr. Frank Crane of his definitions of "efficiency." He says:

It is the measure of a man, the size of his soul.

It is the ability to use his passions, likes, dislikes, habits, experience, education, mind, body and heart—and not to be used by these things.

It is self-mastery, concentration, vision and common sense.

It is the sum total of all that's in a man.

Once more, my son, I say "Be Efficient."

Quincy, Mass. COLIN ARTHUR.

Novel Ignition Arch Construction in B. & A. Shops

In the latter part of October a member of the *Power* staff visited the power plant of the Boston & Albany R.R. shops in West Springfield, Mass., where a novel

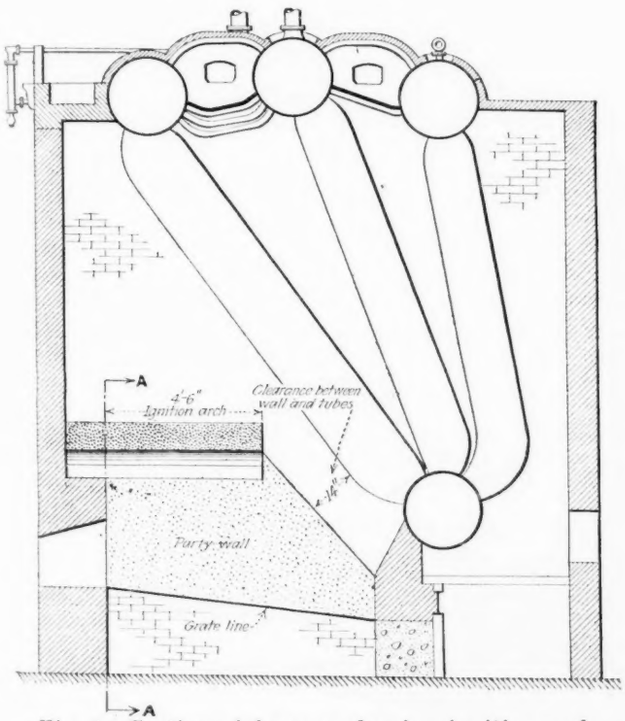


Fig. 1—Section of furnace showing ignition arch

type of ignition arch is being tried out under a 3,500-sq.ft. hand-fired Stirling-type boiler.

This particular boiler house has four boilers of this type and size. Originally, each furnace was equipped with a double ignition arch of brick with a center supporting wall between the two firing doors. Continual forcing of the fires resulted in rapid deterioration of the brick with consequent high maintenance expense.

To eliminate this trouble, it was decided to remove the brick arches from one of the boilers and replace them with arches of similar proportions but made in a single piece from plastic refractory pounded into place over forms.

The construction is clearly shown in Figs. 1 and 2. As indicated in Fig. 2, the radius pieces of the form had a 9-in. rise. These were cut from 2x12-in. planks. The radius pieces were covered with tin to retard burning out and were supported on firebrick piers, on which was laid 3-in. pipe. Perforated sheet metal was stretched over the tops of the radius pieces. On top of the sheet metal 2x$\frac{3}{4}$-in. lath was nailed. The plastic refractory was then pounded into place over this form. After a brief air drying a slow fire was started. The fire was brought up after two days, burning out the wooden forms.

The job was finished early in September and has

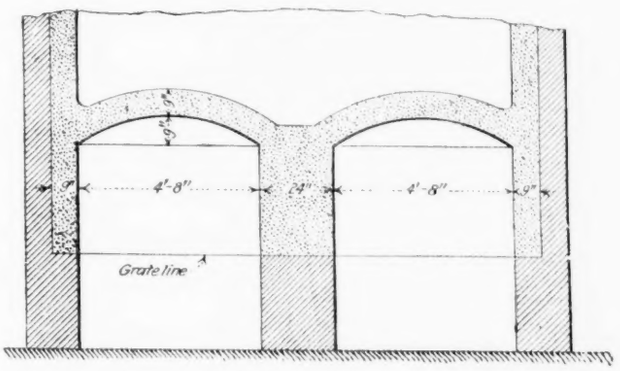


Fig. 2—Section AA (Fig. 1) showing arch contour with span of 4 ft. 8 in. and rise of 9 in.

since been subjected to heavy and continuous firing. When inspected late in October, the arches and supporting walls appeared to be in perfect condition, free from cracks, slagging, erosion or spalling. The chief engineer, W. H. Mason, reported that no trouble of any sort had been experienced. Similar experimental arches have been installed under one of two 3,380-sq.ft. horizontal tubular boilers in the Boston & Albany R.R. station at Springfield and under one of five 1,500-sq.ft. return-tubular boilers in the engine (locomotive) house at West Springfield.

The accompanying unretouched photograph (Fig. 3), taken Oct. 23, shows the furnace first mentioned op-

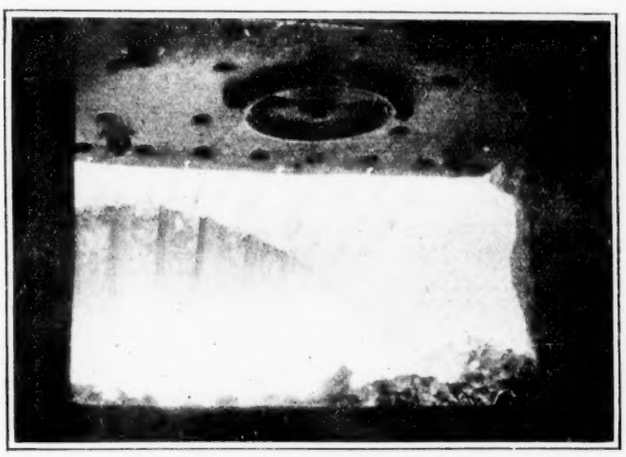


Fig. 3—Unretouched photograph of furnace carrying hot fire

Left-hand door is swung up for picture, revealing much of arch and party wall (right). The original mold marks still show on the arch. Beyond its curved edge parts of five tubes are visible.

erating with an intense fire. The center wall and underside of the left arch, as well as portions of the tubes, are visible through the flames.

The construction of the arches in this manner was suggested by engineers of the Plibrico Jointless Firebrick Co.

Unaflow Engines Drive High-Pressure Compressors

By PROF. J. STUMPF*

Single Beat Valves and Special Valve Gear Used on German Engines — Clearance Volume Very Small — Compressors Use Six Stages, Compressing to 3,300 Lb. per Sq.In.

WHERE the output of high-pressure compressors must vary, a direct-connected steam engine is often preferable to motorization or to geared turbine drive. Unloaders are not as efficient in controlling capacity as is the regulation of the compressor speed, but neither the motor nor the turbine is susceptible to any great speed change save at a sacrifice in efficiency.

In the ammonia works of the Badische Anilin and Soda Fabrik in Leuna, near Merseburg, Germany, 75 unaflow engines are direct connected to 6-stage compressors. These units have been installed from time to time and differ somewhat in minor details, being built by various engine manufacturers. The requirements of the processes have led also to some differences in the compressors.

All compressors have two frames and are developed in six stages, with intercoolers. The low-pressure stage is placed ahead of the single unaflow cylinder, and the other stages are bolted to the second frame. Starting from the frame the order is as follows: 4-stage, 3-stage, 2-stage, 5-stage and 6-stage. The 1- and 2-stage cylinders are double-acting, all the others being single-acting.

One of the last units to be installed in Leuna is of interest inasmuch as the unaflow cylinder has an unusual valve gear. The cylinder is 25.59 in. in diameter by 31.66 in. stroke and is supplied with high-lift single-beat valves.

*Inventor of the Stumpf Unaflow engine.

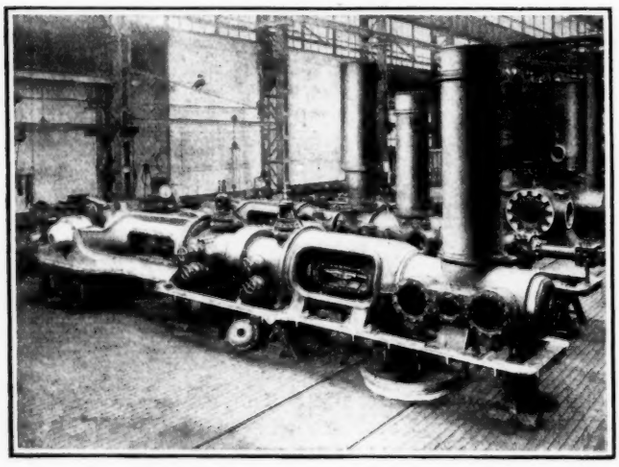


Fig. 1—Unaflow-engine-driven compressor

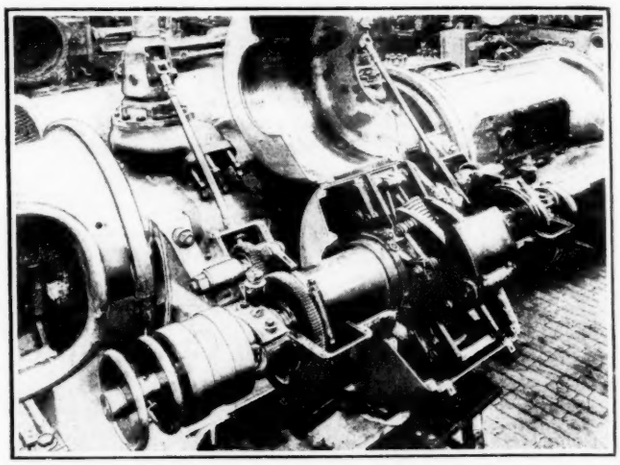


Fig. 2—Gear case, showing governor and 1-to-2 gear

The usual types of valve gears with fixed lap necessarily give very small valve lifts at early cutoffs. In order to obtain the necessary valve area when slide valve gears are used, a large travel and considerable lap must be provided, and this results in large friction losses and leakage. In poppet-valve gears very steep cams become necessary. In order to alter the cutoff, the eccentricity has to be changed, and since cutoffs up to 50 per cent must be provided for in many cases, the eccentric travel for early cutoffs is short and therefore the resultant valve lift is small. Instead of trying to accomplish the work with small valve lifts and large diameter valves, it would be better to use large valve lifts and small valves.

A high valve lift is obtained through the use of a two-speed gear shown in Figs. 2 and 3. The main layshaft, placed along the engine frame, runs at engine speed. On this shaft are placed the two shifting steam eccentrics *A* shown in Fig. 3. Each eccentric strap *C* is connected to a rocker *B* which moves the valve lift rod. The rocker *B* is carried on an eccentric *D* mounted on a short shaft geared to the layshaft so that *D* runs at twice the engine speed. The motion of the eccentric *D* causes the valve to open very quickly and close with equal rapidity, at the same time obtaining a high lift.

The cam *E* has two curvatures in its lifting face. At the beginning of the valve lift the cam curve has a slowly increasing radius and as soon as the valve is off its seat the steep cam face contacts with the roller, raising the valve at a rapid rate. In spite of the high lifting speed the gear is quiet in operation and the reaction on the governor is less than with the usual gear. The high lift feature permits the valve diameter to be small and at the same time reduces the surface of the steam passage. Hammering of the valve on its seat is eliminated, inasmuch as the closing valve is exposed to a gradually increasing pressure drop and the force exerted on the valve does not reach its maximum until the valve seats.

The steel valve seat is pressed into the cast-iron housing and rolled, or expanded, into place. The design results in a small clearance, amounting to about

1 per cent, even though the space between the piston and head is comparatively large. If the rod were screwed into the crosshead in place of the present key arrangement, it should be possible to further reduce the clearance.

The port given by the open valve in connection with the seat is a nozzle-diffuser, resulting in smooth transitions with a minimum of resistance. The performance is brought about by the high valve lift, entailing a

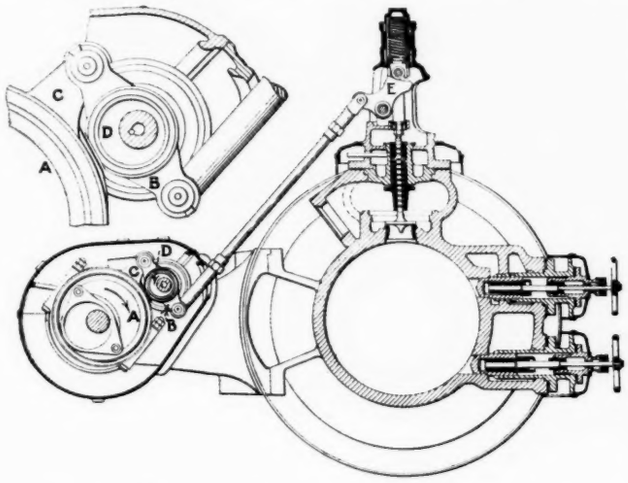


Fig. 3—Cross-section of cylinder and valve gear

small diameter and a small internal surface of the steam passage, which is machined all over. Of course the highest speed will be in the narrowest section, where the pressure will sometimes drop to the critical pressure and the increasing section of the diffuser will produce a suction on the narrowest section between the seats, thus increasing enormously the quantity of steam passing the valve.

A surface condenser is used, in conjunction with a cooling tower. Scale formation during part of the year changes the vacuum from 92 per cent to 75 per cent. To accommodate this increase in back pressure an extra clearance space of 1 per cent is provided, in addition to the large extra clearance volume used when operating against atmospheric back pressure.

Upon a five-hour test the steam consumption was 11.3 lb. per indicated horsepower-hour, the steam pressure being 207 lb., with a total temperature of 466 deg. F. and the condenser pressure 1.2 lb. absolute.

Heating and Induction-Motor Windings

By A. Narducci

After cutting out a damaged coil in a 40-hp. two-phase squirrel-cage type induction-motor's stator winding, I was told by the foreman to connect the winding to line voltage and test it before assembling the motor. My reply to this was that there was danger of overheating the winding, but upon the insistence of the foreman that the resistance of the winding was the same whether the rotor was in the stator or not, I closed the switch. It was not long until my contentions were shown to be correct, by smoke issuing from the winding. The motor was then assembled and the power applied again, with satisfactory results.

The current in the stator winding is limited by the ohmic resistance of the winding and also by the counter-electromotive force, just as in a direct-current armature. The counter-electromotive force in the stator winding is produced by self-induction, similar to the counter-electromotive force in the primary winding of a transformer. The more dense the magnetic field the higher the counter-electromotive force and the smaller the current taken from the line. The density of the magnetic field depends to a large extent on the amount of iron in the magnetic path. With the rotor removed, it created a long air path for the lines of force from one pole to another, consequently a large current had to flow in the winding to set up the magnetic field through the air. Furthermore, whatever value this current attains it remains at that value.

With the rotor in place there is only the short air gap between the rotor and stator cores and a much smaller current would be required to set up the magnetic field if it were not for the winding on the rotor. A squirrel-cage winding on the rotor forms a closed system of circuits, which acts as a short-circuited secondary on a transformer and tends to reduce the magnetic field set up by the stator winding. This action of the rotor on the stator causes a large current to be taken from the line when the motor is first connected. As the rotor comes up to speed, the current in its windings is reduced, which reduces the demagnetizing effects on the stator, and the current in this winding decreases as the counter-electromotive force increases.

If the rotor were locked so that it could not turn, the stator winding would take such a large current as to cause it to overheat in a very short time, just as when the rotor was removed. With the rotor in place the current decreases to a safe value under normal conditions, as the rotor comes up to speed, whereas with the rotor removed the current remains at its original value and overheats the stator winding.

There is also another effect that tends to increase the temperature of the stator winding with the rotor removed, and that is the lack of air circulation over the windings. When the motor is running, the rotor causes air currents to pass over the stator winding and carries away the heat as it is dissipated to the surface of the coils and core. With the rotor removed, the heat is not so readily carried off in still air, therefore, for a given current in the winding the temperature would be higher.

On a wound-rotor motor with the rotor locked, the current will remain at a low value if the stator is connected to the line. Since the rotor windings are open-circuited at the slip rings, they have no current flowing in them and consequently can have no demagnetizing effect on the stator. In other words, the motor will act as if a very high resistance were connected in series with the rotor, and the windings will not heat as in the case of a squirrel-cage motor, if the rotor were locked and the stator winding connected to the line.

A general test for presence of acid in oil is to apply a few drops of blue litmus paper, which has the property of changing to a reddish color for the application of an acid. To obtain the reaction on litmus paper, it is customary to moisten the paper with water before applying the oil, but the water thus used may be so alkaline as to neutralize the acid in the solutions. A surer test for acid is to place a small quantity of the oil on a freshly polished brass surface, and if acid is present it will etch the brass in about 36 hours.

Heat-Balance Testing of Centrifugal Compressors*

M. G. ROBINSON

A NEW method of testing the power input to centrifugal compressors was presented by M. G. Robinson. It was pointed out that centrifugal compressors are often driven by steam turbines with and without intervening gear trains. To determine the shaft power transmitted to the compressor by its driver, from efficiency tests on the turbine and estimates of the gear losses, involves considerable labor, time and expense. The heat-balance method is simpler and more direct. In this method the principle is used that a balance exists between the mechanical energy supplied by the rotation of the shaft and the heat energy increase in the air that is being compressed, the heat energy increase in the cooling water used, and the heat lost from the casing, bearings and packings. With proper testing apparatus and due precautions this heat energy may be accurately measured and hence the power input established. Satisfactory results have been secured by the application of this method. The author gave details of the fundamental theory, some representative test data and a complete description of the apparatus used.

The theory underlying the method is simple, that all the energy input still is in existence, either being in the delivery air, or has been lost in the cooling water, shaft leakage or in the radiation from the machine, etc. The author then outlined his method of computing the total input by ascertaining these several losses. He pointed out that the specific heat of the air was nearer 0.242 than the value usually taken. The value varies with the pressure and with the humidity, correction charts being given in the paper. The energy in the discharge air is calculable by any of the known methods.

The energy absorbed by the cooling water may be as much as 50 per cent or even more of the total energy supplied, and hence all precautions possible must be exercised in its determination. Fortunately, this is usually not very difficult. It depends on the product of the temperature rise and the weight of the cooling water that is being circulated. Usually, there is practically no variation in the temperature of the water as it flows through the inlet pipe. Hence, in determining its temperature all that is necessary is the use of a sufficient number of properly calibrated thermometers with sufficiently fine graduations.

To find the energy dissipated into the surroundings from the casing surface during the progress of the test, careful measurements are made of the temperature of the various parts of the casing. The temperature of the surroundings is also observed. Each test point is held a sufficiently long time to insure constant thermal conditions having been attained. It should be noted that the energy loss from this source in case of water-cooled machines is small. In case of machines without water cooling it may be of importance.

Whenever possible, the bearing loss is determined by test. During the performance test care is taken to have oil of the same viscosity as that used during the bearing tests. When a calorific test is made, the oil and water should be weighed preferably to being metered through an orifice, and due precautions taken to run the test long enough to insure constant conditions.

The clearances existing between the packings and the shaft are carefully measured both during the process of assembly and after the test. Throughout the test observations are made as to the condition of the packings, so that any imperfection resulting in an unduly large leakage is quickly noticed.

It was the author's conclusion that the method is less expensive and more accurate than obtaining the output of the driving engine or motor.

*Abstract of paper presented at the recent annual meeting of A. S. M. E.

The Industrial Picture Through the Focus of Research*

BY MAURICE HOLLAND†

The relative importance of research to industry in various countries is indicated by the fact that in England the British government has a subsidy plan by which an appropriation of approximately five million dollars was made some years ago to encourage the establishment of co-operative research associations in various industries. At present there are twenty-six active research associations operating under this plan.

In this country, while there is no governmental department directly charged with the specific duty of encouraging research, the National Research Council has been organized to perform this function. Without being an integral part of the government, the Research Council operates under the Congressional Charter of the Academy of Sciences and by an executive order of the President is assured of the full co-operation of our government scientific and technical bureaus.

We are spending approximately one hundred million dollars a year in the United States for research. The government, with its many scientific and technical bureaus, and research agencies attached to practically every department, is spending approximately one-third of this amount, while industry is matching dollars spent for research two to one for the government expenditures. There are nearly 600 industrial research laboratories in the United States excluding the government bureaus and research agencies connected with the universities and technical colleges. The trade associations alone are spending approximately twelve millions a year for research.

One hundred years ago industrial supremacy, either by an industry or by an individual concern, was largely a matter of the control of raw materials. Within the last twenty-five years this new factor, industrial research, has considerably changed the state of affairs.

Industrial research not only affords technical superiority in competition between industries, or provides an advantage to the concerns within an industry which is competing with its fellows, but it is an even more dominating force in the present-day industrial structure, since it creates industries and even destroys them—destroys, in that it revolutionizes the present processes, invents new ones, and therefore is the primary cause for the creation of a new industry or the specialized subdivision of the same industry.

*Extracts from a paper presented before the Fall Meeting of the American Welding Society, Boston, October, 1925.

EDITORIALS

F. R. LOW, EDITOR

Not Seen at the Power Show

MEASURED by the number of exhibitors, the character of exhibits and the attendance, the Power Show this year was better and bigger than ever. Aside from two or three turbines, there was a marked absence of prime movers. This was especially regrettable as concerned steam engines, for it tended to confirm a popular misconception that they have nearly, if not completely, passed out of the picture. A visit to a few of the engine builders' shops would show this to be far from true, but unfortunately, very few of those who visited the show are privileged to make such first-hand observations.

It is quite true that preferred space was taken up by manufacturers of smaller equipment, who have been exhibitors from the first, but that is the other fellow's misfortune through lack of foresight three years ago in not appreciating the possibilities of the Show.

While one hears practically a unanimous opinion that the Show, as an established event, is the biggest thing in the power field, it nevertheless needs more steam engines, steam turbines and oil engines. The psychology of their absence is damaging, not so much to the Show but to the industry.

Keeping Up With the Job

"THE day of the old-fashioned engineer, who knew little of theory and cared less, is long past. The cost of fuel is too high for indifferent or careless operation, and inefficiency has too great an effect on the cost of production to pass unnoticed." These are the words of a practical power-plant executive, a man who has been through the mill himself and has now supervision over power plants of the United States Rubber Company. The reference is to W. H. Larkin, Jr., and the quotation is taken from his A.S.M.E. paper, "The Supply of Industrial Power," an abstract of which appears on page 929.

Mr. Larkin does more than sound the death knell of complacent ignorance; he goes on to say: "No power department is well operated which does not produce regular and understandable data on power operating efficiencies and costs that can be compared from month to month with records of similar plants."

The power house was one of the last departments of the industrial plant to submit to scientific cost control. This was undoubtedly due to the fact that the chief executives of industrial plants, as a class, knew much less about the details of power production than about the work of other departments. As a result, while they felt that some sort of detailed cost figures should come out of the power plant, they were not in a position to explain what sort of costs were wanted or how the data could be obtained. Today many power-plant engineers have started keeping adequate costs, pointing the way for handling such matters. The executive can refer to what other engineers are doing and ask his own engineer why he is not doing as much. The engineer is entrusted with a tremendous investment and allowed to control large expenditures for fuel, labor and repairs. It is only fair that he should show the management how this money is spent and what return is being obtained in the way of power, process steam and other services.

When there is real logic behind any general movement, it is folly to buck the tide. The thing to do is to swim with it. Why should not the engineer win credit for initiative and vision by starting at once, and of his own volition, what he will eventually be compelled to do in any case?

Hydraulics in Steam Power Plants

HYDRAULIC engineering plays an important part in steam power plant design. The desire to secure the highest possible vacuum on large modern turbines necessitates the pumping through proper channels of great quantities of cooling water for the condensers. The mechanical engineer has not always carefully considered the laws of hydraulics in the design of these parts of the plant. For instance, he has not always designed his intakes to secure the deepest and coldest water available but often permits portions of the warm surface waters to enter his condensers.

Any unnecessary losses of head in pumping condenser cooling water cause fixed losses of power throughout the whole life of the plant. Upon the designer therefore falls the responsibility for careful study of every feature of his plans to see that he has secured the best economic operating conditions. He must balance cost against savings in making these studies.

Cooling water intake tunnels should draw from the lower and colder water. The inlet opening should be wide and shallow so that velocities are low. It has been noted in city water supply intakes that square-ended intakes usually draw a cone of water from above and hence collect much warm surface water.

The intake tunnel itself should have no obstructions and be built for smooth flow without bends, if possible, to the pump intakes. The location of suction pipes in confined niches in the side of the tunnel is particularly undesirable. Eddies in such places cause energy losses and should be avoided. Pump intakes of low-velocity inverted funnel type also aid in reducing hydraulic losses.

The piping to the condenser should have the most liberal bends possible. Internal sleeves in expansion joints cut down eddy losses. Much can still be done to lessen hydraulic losses in condenser design, and this is now receiving attention. The losses entering the condenser tubes are susceptible to considerable reduction.

Discharge pipes should embody the principles of the expanding draft tube used in hydraulic turbines so that the velocity head of discharge may be recovered. Similarly, the outlet of the discharge tunnel should be flared out to convert its velocity into pressure head and

particularly to distribute the warm water over the surface layers and not into the lower water from which the intake is drawn. The tunnel must also be kept free from obstructions, unnecessary bends and eddies.

It has been said that a possible saving of ten per cent in power to circulating pumps may be effected in many steam plants by correctly applying hydraulic principles to the design of the condenser system.

Avoiding Hot Bearings

IN THE effort to obtain proper bearing temperatures are not engineers working in the wrong direction in centering their attention almost exclusively on the lubrication factor?

Probably the tendency to attribute a hot bearing to inferior oil is natural, as the trouble is encountered in machines of the highest reputation for workmanship.

Investigation has revealed that while the oil may frequently be at fault, the important factor is the design of the bearing. It has been proved that an oil film must be maintained between the journal and bearing, and this film is by no means of uniform thickness, the shaft center being shifted from the bearing center. This eccentricity is the underlying cause of many bearing troubles. It is a tradition that the bearings of a high-grade machine should be scraped to fit the journal and the clearance consists almost entirely of the babbitt removed in the final bedding of the shaft. When the machine is started, the lack of clearance prevents the existence of a proper oil film. That the metal should become heated is not strange, and it can be kept cool permanently only by a readjustment of the bearing. In a poorly built machine scraping is not practiced and the clearance is usually ample to permit the shaft to find its proper position.

The remedy in an existing machine is to scrape the bearing to a somewhat larger diameter than the shaft. This permits the oil film to remain unbroken. The proper solution for the designer is to study the bearing problem with more attention to existing facts. If this were done, there would be fewer engine bearings with the separation or split at the point of maximum pressure. The oil would be introduced at the logical point and probably oil grooves would be entirely abandoned, as apparently their sole effect is to break the oil film.

It All Figures Back To the Fuel Pile

OPENING the gates for the water to flow through a hydraulic turbine, no more represents the problem of operating a hydro-electric plant than shoveling coal into a boiler furnace, without any further consideration of the combustion process, is indicative of proper steam-plant operation. In both classes of plants large losses result if proper operating technique is not followed. Where there is always an excess of water for the power needs supplied by a hydro-electric plant, efficient operation is of no particular importance, except to keep the units loaded to where the runners will be least likely to pit.

Water-power plants that are favored continually with an excess of water are in the minority and are becoming fewer each year. On a large majority of the hydro-electric systems there is a shortage of water at least part of the time, and in many cases at all times, that must be supplied by steam power, so that every kilowatt-hour that can be obtained from the hydro-electric stations means the burning of that much less fuel.

Last year in this country there were generated twenty billion kilowatt-hours in hydro-electric plants. It is not uncommon for a hydro-electric plant to be producing ten per cent less power from the water available than could be obtained from the equipment installed. On this basis there is the possibility of two billion kilowatt-hours loss in hydro-electric stations in this country. If this power has to be produced from coal, allowing two pounds per kilowatt-hour, it means burning two million tons of coal that might be avoided.

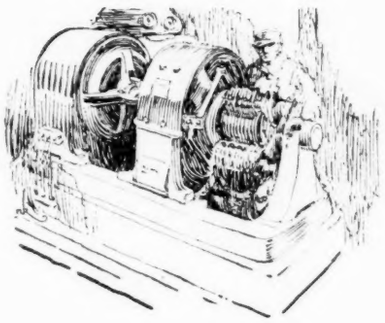
Ten per cent for the losses due to improper operation in a hydro-electric plant is a low figure. This can easily occur owing to improper loading of the units alone. A recent case in mind, where a schedule for the most efficient loading of the units was worked out and put in operation in a large plant, resulted in ten per cent increase in the kilowatt-hours for the same amount of water passed through the units. This plant was supposed to be intelligently operated before the tests were made and the loading schedule adopted.

Improper loading of the units, or not having the correct number on the system to carry the load most efficiently is only one of the causes of loss. Other common causes are loss in head due to carrying the forebay level too low, the racks being clogged with trash, obstructions lodged against the turbine guide vanes or gates, or obstructions lodged in the tailrace. Badly pitted runners and excess clearance in the runner seals, due to wear is another contributing factor. Then there is the loss of water due to wastes over the dam, leaky gates in the dam, leaky flash boards and leaks through the gates of idle units. The latter is a common cause of large losses, since it cannot be seen and is likely to be overlooked unless the operator is onto his job.

The increased cost of fuel has forced greater attention to the operation of steam plants to obtain the highest efficiency. In the final analysis the waste in a water-power plant figures back to the fuel pile, where the deficiency of hydro-electric power must be supplied by a steam plant. Therefore it certainly is not sound economics to give careful attention to more economical operating of steam plants and neglect water-power plants. A number of the large water-power plants are giving careful consideration to the operating problem and have found that it resulted in handsome returns, but there still remains many of the open the gate and let the water flow type.

The joint letter sent recently to the anthracite operators and miners by a group of distinguished economists and engineers, published elsewhere in this issue, gives some suggestions that are extremely pertinent and should prove helpful in the situation in which the anthracite industry finds itself. The letter points out that "no agreement will insure continuity of production and distribution in the future which fails to provide a continuing joint agency that will concern itself, not so much with the adjustments of grievances as with the constructive consideration of the underlying economic and technical facts." They also state that they believe that "joint effort on the part of management and workers in improving methods of production and distribution can increase wages and lift and stabilize earnings at the same time that they lower the price to the consumer."

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for November will be announced next month.

Power is pleased to announce the awards of the judges for the first and second prize contributions received during October for this department in accordance with the terms of the contest as stated above.

The first prize of $25 goes to J. A. Madsen, of Chicopee, Mass., for his article on "A Little Investment Returns Big Dividends" in the Dec. 1 issue.

The second prize of $15 goes to A. J. Nichols, of College Station, Pa., for his article on "Why an Oil Engine Ran Away" in the Nov. 17 issue.

The judges were: (Chairman) Willis Lawrence, mechanical engineer, Interborough Rapid Transit Co., New York City; Norman N. King, chief engineer, Singer Bldg., New York City, and D. L. Fagnan, formerly refrigerating engineer and more recently associated with the Smoot Engineering Corp., New York City.

Change of Coal Makes a Saving in Operating Costs

By the expenditure of $15 and the selection of a coal suited to the plant conditions, a monthly saving of over $100 was made in a small plant. This plant consists of a direct-connected steam engine with an average load of about 30-kw. An open heater and a duplex pump were used to supply the feed water to a horizontal return-tubular boiler that had 22.5 sq.ft. of grate surface. The monthly coal consumption ran around 35 tons of bituminous coal, costing $8.25 per ton. In addition to the steam needed by the engines, live steam was used for process work. The only record kept was the coal bills. The changes made were as follows:

A discarded closed heater was placed in the exhaust line, to raise the temperature of the process water to an average of 90 deg. It was connected so that when the water was not being used for processing, the make-up water for the open heater passed through the closed heater. Changing the coal from bituminous to small anthracite of a grade selected to suit the plant conditions, the consumption was reduced to 28 tons a month, costing $6.25 a ton. In other words, a saving of over $100 a month was made at an initial expense of but $15. This makes the savings show a yearly return of 8,400 per cent.

R. W. CATER.

Philadelphia, Pa.

A Quick Boiler Repair Job

The boiler installation in our plant includes a 7,500-sq.ft. horizontal water-tube unit with a convection-type superheater placed in the combustion space just behind the bridge wall. The boiler is built for a working pressure of 225 lb. gage, and the superheater is designed to give 100 deg. superheat at normal rating. After this particular unit had been in service for about 14 months, during which time it was operated at about 200 per cent of rating, it began to give trouble due to leaking at the rivets in the girth seam.

The water used for feed has approximately 115 parts per million of scale-forming solids. When the boiler was first placed in service, it was decided to use the same metal treatment for scale that we were using on the other boilers, which operated at 150 lb. pressure and with no superheat. In 25 days the centrifugal boiler-feed pumps were choked up with a hard lime and magnesium scale. The pump runner was so badly scaled that it had to be cleaned with acid. This naturally made us decide that the metal treatment was not good for the high temperature.

Boiler compound was our next bet, so we bought a guaranteed compound to fit our boiler-feed water. After a careful analysis of the raw water this compound was made to do the proper work of changing the scale-forming substances of the water to non-scale forming. But owing to the method of feeding this into the boiler-feed water and the high contents of free hydrochloric acid, we were unable to control the concentration of the boiler water. This was due to the unequal amounts fed and could not be taken care of by blowdowns of any fixed schedule. After some six months' use it was decided to use a water-treating plant. Not caring to waste any more than was absolutely necessary by blowdowns, we ran this boiler for about five months with from 50 to 60 grains per gallon concentration. Here is where the fun began. All the rivets on the girth seams at the bottom of both drums showed signs of leaking. The laps on the bottom also showed a white formation. The boiler inspector advised that all leaky rivets be cut out and new ones driven as well as the roundabout chipped and recalked.

Conditions were such that we could spare this boiler only on Sunday. The boiler manufacturer was notified of our troubles, and he immediately dispatched a foreman with two boilermakers and two helpers and the necessary equipment to our assistance. This boiler was removed from the line at 11 o'clock Saturday night

and a start made on the repairs as soon as possible. Sixty-four 1⅛-in. rivets were cut out of the two front girth seams on the two drums and new ones driven in their place. The sheets were chipped and recalked halfway around both front girth seams. The boiler was again placed on the line at 4 o'clock Monday morning.

In all the boiler was off the line just 29 hours. At no time was the temperature in either drum below 250 deg. The reason given for the defective rivets was caustic embrittlement. Since this trouble another boiler of the same design and size has been added, and a 10,000-sq.ft. boiler of the cross-drum type is now being installed. L. HANSEN.

Lawton, Okla.

Boiler-Feed Pump Used as a Wet Vacuum Pump

In order to avoid excessive compression pressure in a unaflow engine set up for test purposes, it was necessary to devise a temporary condensing plant. A vertical water-works condenser was available, but there was no wet-vacuum pump. A 4½x2x4-in. duplex steam boiler-feed pump was available, and it was used in place of a vacuum pump. The pump suction was connected to the bottom of the steam space of the condenser, and the discharge was left open to atmosphere. Because the clearance in this improvised vacuum pump was large, the vacuum obtained was only 11 in. of mercury at full load and 17 in. at no load.

In order to secure a still better vacuum, a 5x3x7-in. simplex boiler-feed pump was connected in series with the duplex pump, the suction of the simplex pump being connected to the discharge of the duplex pump, and the former's discharge opening to atmosphere. This

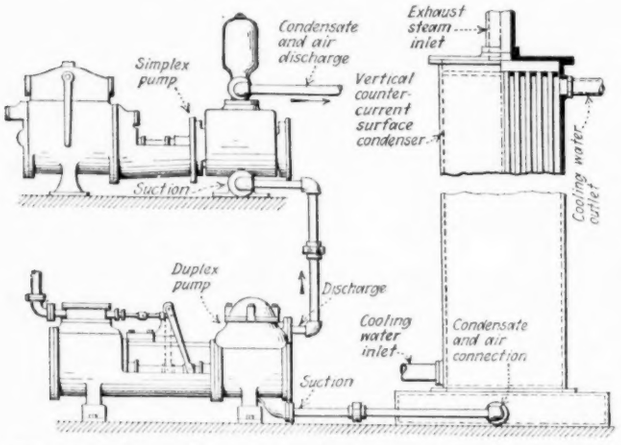


Fig. 1—Connecting pumps in series for wet vacuum operation

arrangement, shown in Fig. 1, gave a vacuum of 21 in. of mercury with no load and 16 in. with full load.

Steam- and air-cylinder indicator diagrams taken on the simplex pump are shown in Fig. 2. It is interesting to note how the material pumped affected both the steam and water end cards. The pumping of water ordinarily gives steam and water indicator diagrams that are substantially rectangular as shown in Fig. 3. In this case, however, the resistance to motion of the steam piston by the air and water mixture was small during the first part of the stroke and the piston ran away from the steam, causing a drop in pressure as shown. Near the end of the stroke the increased resistance opposed to the steam piston by the compressed-air and water mixture caused the piston to slow down, allowing steam to build up to the supply pressure. On the return stroke the piston traveled so fast that the steam could not be freely exhausted, as is shown by the high back pressure. When the piston slowed down

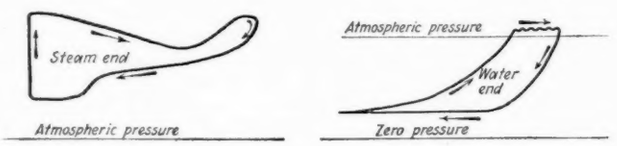


Fig. 2—Indicator diagrams of the simplex pump

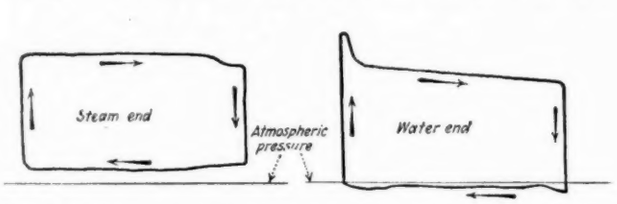


Fig. 3—Diagrams usually obtained from steam-driven water pumps

toward the end of the stroke, the pressure dropped to that in the exhaust pipe. This type of diagram is typical of the steam end of a certain type of wet vacuum pump, and the steam end of a Westinghouse air-brake pump. Evidently, precisely the same conditions prevail in any type of pump used in such service. In this case the large clearance of the pump cylinder gives compression and expansion lines in the air cards which are less steep than those obtained from a cylinder designed expressly for such service. A. J. NICHOLAS.

State College, Pa.

Burning Coal in Small Plants

Much space in technical publications has been devoted to large plants, where stokers or pulverized-coal equipment is used with large boilers. As there are still thousands of plants using hand-fired boilers, more attention is due them. While statements to be made apply more particularly to the use of bituminous coal, many of them may be applied to the burning of anthracite.

Fig. 1 illustrates a wasteful kind of a fire. It is quite thick in front, but slopes towards the bridge wall, therefore when an incompetent fireman opens the furnace doors and views the interior, he is sure that a brisk fire is burning. As there is little or no coal at the rear, where the fire naturally burns very brisk, a large volume of air rushes in and tends to lower the temperature at this point. This is the type of firing followed by green firemen, and it is most difficult to correct, because the fire is apparently in good order when viewed from the front.

Where the fire is so thick at the front, it keeps the arch plate just above, nearly or quite red hot; consequently, it is burned out much more rapidly than is really necessary.

One of the most economical plants with which I am familiar, is run with a 3-in. space at the front of the grates clear of coal at all times. This allows air to

enter, pass up over the burning coal and mingle with the hot gases, giving excellent combustion by the time the gas has passed the hot bridge wall into the combustion chamber. The bridge wall is flat on the top, and it is about 12 in. below the boiler at the center, thus giving ample space for the products of combustion to pass away without impeding the draft.

Another defective type of fire is illustrated in Fig. 2; it is in contrast to the one shown in Fig. 1, as it is thin in front and thick near the bridge wall. A large portion of the air that is admitted to the ashpit, comes through

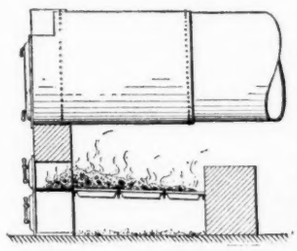


Fig. 1—All the coal is at the front

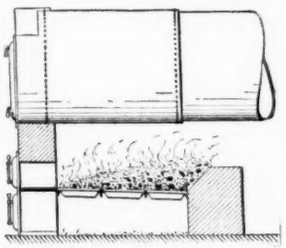


Fig. 2—Thick fire is next the bridge wall

the fire at the front. It must pass entirely over the fire, and in some cases this may prove to be an advantage. No hard and fast rule can be laid down that will apply to all cases, as experiments must be made in order to determine the best method for each case. However, this method is not recommended on general principles.

A very even and thick fire in conjunction with a high, square bridge wall is illustrated in Fig. 3. Whether the fire is thick or thin, the only duty of the wall is to hold the coal in place. This fact is mentioned because some engineers and firemen appear to think that it is for the purpose of forcing the products of combustion up against the boiler. As proof of this, one case is mentioned where the bridge wall under a pair of large tubular boilers was built to within 3½ in. of the shells and laid in the form of an inverted arch, in order to conform more closely to the shells. The chief engineer claimed that a saving of coal was made, but could not show the report of a test to prove it.

While visiting a certain plant, I noticed a novel plan for replenishing the soft-coal fires. Two husky firemen would throw the doors open, and then one of them would shovel left-handed and the other right-handed until the furnace was so full of coal that it would run off from the dead plate and form a pile on the floor.

I formerly had two boilers under which the bridge walls were low inasmuch as hard coal was being used. When the change to soft coal was made, these walls appeared to be too low, for it was necessary when banking fires to cover them quite thick to prevent making steam. Some of the coal lodged on the bridge walls and was an aggravation. To prevent this, one row of bricks was added, bringing them up to within about four inches of the shell at the center. The boiler inspector objected to this and had them cut down.

The thick fire shown in Fig. 3 is favored by many firemen, or at least their practice seems to indicate it, but this does not prove that it is more economical than one-half of the thickness would be. Where the draft is strong and the boilers are forced much beyond their rated capacity, there may be some excuse for carrying a moderately thick fire, but the average fireman would much rather shovel in 500 lb. or more at once and then sit down until more is wanted, than to use smaller quantities at shorter periods. As a test case I had one of my firemen shovel onto the scales the amount of coal that he usually throws into the furnace, and it weighed 52 lb. This certainly is an economical method of firing, as the following incident proves:

A fireman persisted in carrying a fire as shown in Fig. 3. For a long time it took a certain weight of coal a day to supply the regular load. Finally, the manager discharged him and hired another. This fireman persisted in carrying a fire as illustrated in Fig. 4. I observed his work one day, and while I did not have scales to weigh the charges of coal, I am sure that they did not weigh more than 25 lb. The furnace doors were opened frequently and he did not have time to rest, but the results showed that the coal bill was reduced 25 per cent. No other change was made at this time.

In still another case the manager of a plant requested me to lend him one of my firemen for three days. I complied and instructed the fireman to follow the same method as he did in his regular plant. This manager employed a fireman who carried fires as illustrated in Fig. 3. The borrowed fireman followed the system shown in Fig. 4. The report was a coal saving of 40 per cent. Changing firemen was the only change made in this plant.

It is claimed by some that fires should be carried about 14 in. thick. The argument is that it is impossible for any air to pass through such a fire without aiding in combustion. This is true, but could not the same claim be made for fires 5 in. thick? Why should such a claim be persistently maintained when it has been proved that thin fires, carefully attended to, are the most economical?

Fig. 4 represents the thinnest fire that I have ever seen in actual service. It was produced by a fireman who had given such matters much attention. He followed a fireman who left fires about a foot thick, and in an hour he had them reduced to two inches.

Another fireman adopted the following method: He had furnaces that were fitted with two small doors. He

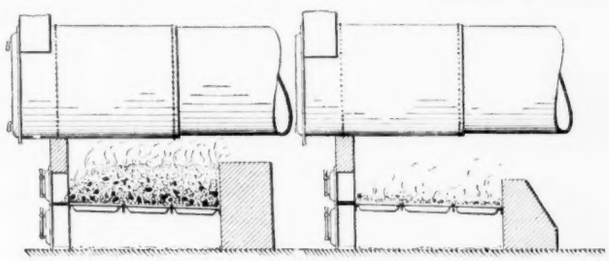


Fig. 3—Some firemen believe in this kind of fire

Fig. 4—A thin fire is more economical in many plants

would open one of them, throw in a small quantity of coal, then quickly shut it. After waiting about three minutes, he would do the same with the other one. The result was a hot fire that was practically smokeless. The objection to this is that it keeps the furnace doors open much of the time. This was overcome in another plant by connecting a light damper to the furnace door, so that when one was open, the other was always shut. It was never popular with the firemen, especially when cleaning the fires. Of course it prevented much cold air from rushing into the furnace, but the back action of heat, soot and ashes was very disagreeable.

New Haven, Conn. W. H. WAKEMAN.

Comments from Readers

"Getting It Across"

The editorial in *Power*, Nov. 10, entitled "Getting It Across," touches on a very important point.

When a salesman induces a plant owner to ignore the engineer's recommendations where changes are to be made or equipment installed, it is not due to the salesman's knowledge of engineering, but to the manner in which he presents his case. To substantiate this statement, one need only refer to the many instances of sales without consideration of efficiency or conditions under which the equipment is used, such as placing stokers with mechanical draft under boilers that do not burn more than six tons of coal in 24 hours, on the ground that the fuel consumption would be reduced.

It seems that the power-plant owner is trying to get something for nothing when he will listen to and take the advice of those who are not educated on the many-phased power problem. Rather than pay a professional engineer, he takes a chance, even though it cannot be disputed that ten out of every twenty installations or changes made without the advice of dependable engineering talent are sources of expense from the start and many are rank failures.

Many plant owners do not consider it necessary to investigate the plant before making any changes, but will actually place an order for such equipment to a man who has never seen his plant and does not know the first thing about its operation.

Tonawanda, N. Y. CHARLES J. MILLER.

The Steam-Engine Indicator

The Foreword by F. R. Low on the steam-engine indicator in *Power* of Sept. 22 should be interesting to the young engineer or student who has looked upon the indicator as a thing of the past. The statement that it has not really seen its day should set a great many of them thinking. Back in 1893, when I was serving time as an apprentice to the machinist trade, in a small cupboard fastened to the shop wall was an indicator. The only one who pretended to know how to use it was our superintendent, but he never did any indicating with the instrument. At this time the indicating of steam engines was a live subject with the progressive engineers, and they all had a copy of "Twenty Years with The Indicator."

I made up my mind I could learn something from the indicator if given a chance to use it, so one day I got up courage enough to ask the Old Man if I could learn how to use it. To my surprise he said I could, even telling me to do my experimental work on the shop engine, which was a Reynolds Corliss, built in 1890. He also stated that I would have to do my experimenting in the evenings on my own time, and that no pay would be allowed for this work.

My enthusiasm went up to a high pitch, and I got busy getting the shop-lighting system in shape for my evening lessons. This was not much of a job, as it consisted of one large kerosene lamp hung up in the center of the shop, but many an evening I spent there in that old shop. It proved to be a very interesting subject, and I learned a great many things I never knew were connected with the work.

Later on the superintendent came to me and told me to indicate all the engines and pumps in the plant. In those days there were no reducing wheels, so I did a great deal of the reducing with the pantograph. On a number of engines and pumps this could not be used, so I had to make a reducing motion that would suit. In computing diagrams I had to use ordinates, and this was a slow, tedious job. When I handed all the diagrams over to the superintendent, he was so pleased that I received my first increase in pay.

I had no instructor to help me out and I ran up against a great many hard problems. In 1906 I took out with the Indicator Instruction Co. course on the indicator, A. C. Lippincott being the instructor. This course was of great benefit to me.

I am of the opinion that the editor was right when he said, "There are plenty of chances still for the indicator and for men who know how to use it." I am sure that being able to indicate an engine and set the valves so that a saving in coal could be made, did me more good than any other engineering knowledge.

THOMAS PASCOE, Master Mechanic,
Norway, Mich. Oliver Iron Mining Co.

Partial Vacuum in Heater Causes Pump to Pound

Referring to the letter of R. N. Ottman in the Nov. 3 issue of *Power* regarding pump pounding caused by a partial vacuum in the heater, we have experienced the same trouble. This plant has an open heater of the induction type and uses the exhaust steam for process work. Our boiler-feed pump is of the duplex steam-driven type. We usually carry about four to five pounds back pressure, and when this pressure is reduced suddenly, the pump begins to pound. We found that by reducing the pressure suddenly and at the same time shutting off the return and makeup water, which comes from a primary heater at from between 170 and 180 deg. F., there was no pounding. Examining the suction pipe near the pump, we found the water was not drawn into the pump in a steady stream but spasmodically, and a little of the water that would be from 212 to 226 deg. F. would turn to steam. When the pressure was gradually built up again and the vacuum gone, the pump became steambound.

We overcame this annoyance by installing a ¾-in. cold-water supply pipe to the suction line near the pump. This can be opened by the fireman when the pump starts to pound. Usually, by the time the valve is wide open it can be closed again in a few seconds.

Needham Heights, Mass. G. M. PHINNEY.

Carbonization of Coal

The case for low-temperature carbonization of coals was well presented by H. W. Brooks in the Oct. 27 and Nov. 3 issues of *Power*, but he omitted the major products obtained by carbonization. These are the benzol and toluol in the 8,000 cu.ft. of gas obtainable from an average ton of bituminous coking coal.

The Germans kept this secret during the many years of their war preparations. It was not until months after warfare began that we learned of their simple inexpensive method of scrubbing coal gas to obtain the highest known explosive. We next realized that a modified 85 Baumé gravity benzol was a motor spirit and that it gave from 40 to 60 per cent more mileage than gasoline.

All over the United States we see small gasoline refineries shut down because they can buy gasoline from the larger refineries cheaper than they can make it. These small refineries have at least 50 per cent of the plant necessary for the carbonizing of coal and the refining of the products. Possibly in another ten years they will realize their opportunity. Capital in this country is usually twenty years behind industrial engineering capital in Europe. J. B. CARPER, B.S., M.E.

Louisville, Ky.

Are Welded Pressure Tanks Safe?

In an editorial in the Nov. 10 issue of *Power* it was stated that unless a hydrostatic test was made in excess of the working pressure, it was not safe to use a welded tank. According to my experience with welded pressure vessels it may be unsafe to use them even after a careful hydrostatic test.

The right way to test a pressure vessel that is to work in a heated condition is to heat the vessel and contents during the test so that conditions will be similar to actual working conditions. However, if the testing pressure is to be considerably higher than the working pressure, considerable danger will be involved in making such a test.

Several years ago I was connected with a concern that used welded pressure vessels as the principal part of its refrigerating system. The generators were operated at about 175 lb. pressure maximum and were hammer-tested at a water pressure of 500 lb. per sq.in. In some of the later tests the water was warmed, but not to what would be considered a dangerous degree in case the seams should let go.

One of these tanks, after installation, containing aqua ammonia, parted suddenly while under pressure, but fortunately nothing serious happened. There was no explosion in the usual sense of the word. The tank split open, fumes escaped and caused much annoyance, and some of the liquor spilled out on the floor. It might have been much worse. There are readers who probably remember an accident that occurred in Brooklyn about ten years ago, in which an entire building was wrecked by the explosion of just such a pressure vessel as this, which contained nothing but aqua ammonia. It was decided that the Brooklyn explosion was not due to any weakness of the vessel, which also by the way was welded, but that it was due to carelessness on the part of the operator, who removed the safety valve and inserted a plug in its place.

Following the occurrences cited, all pressure tanks were carefully annealed after welding and no more parting of seams was experienced. At the same time, naturally, greater care was exercised in doing the welding.

A great many men who call themselves welders are not experts. They know little about annealing. They go ahead and weld up a tank as if it were a piece of straight iron, not realizing that after the welding job is finished internal strains are set up in the metal and that as soon as the vessel is subjected to pressure it is liable to burst. By properly annealing after the welding is finished, these initial stresses are removed and the danger of explosion is naturally lessened.

My personal belief is that in ammonia work and in fact, wherever high-pressure and high-temperature conditions are involved, joints should be riveted in addition to being welded. They should be riveted for the sake of safety in ammonia work and then welded so that there will be no leakage. Although it is expensive, a combination of riveting and welding makes an excellent joint. W. F. SCHAPHORST.

Newark, N. J.

America Already Uses a Decimal System

It would be amusing, if it were not exasperating, to see how many people confuse a decimal system with the metric system and refuse to realize that today we are in this country working with decimal systems. For instance, Baldwin Locomotive Works builds locomotives with the inch as a unit, feet do not appear on their drawings except perhaps those intended for popular exhibition to people unaccustomed to conceiving of dimensions of several hundred inches. Surveying is done on a feet and hundredths basis, and practically every industry has adopted a single unit which, with its decimal multiples and fractions, answers its requirements satisfactorily.

The calm assumption of the superiority of the metric system by its proponents is amusing, as its main basis is the constant repetition that has finally led them to believe it. The great argument of interchangeability of the units of length, weight, etc., is largely illusory, as it holds for only one specified temperature of water and for any accurate work a table of constants is necessary anyway.

To reverse Mr. Kahr's argument, it is a great pity that all the 69 backward nations, or however many it is that have been deluded into accepting the metric system, do not stop going backward and adopt the dollar as a currency unit and the inch and pound as units of length and weight, for if a vote was taken on the basis of value of production in manufacturing, investment in equipment, or volume of manufactured exports, the majority against the metric system would be greater than that against the Democratic party in the Presidential election of 1924.

If the metric system has all the advantages claimed for it, why did not the new industries such as the automobile industry, adopt it with enthusiasm, as they were not hampered by precedent, accumulated designs or equipment and had the example of more advanced European development before them? The metric system has been legal and permissive in this country for almost 50 years, and failing all other arguments, its sponsors are now apparently falling back on the theory of original sin and preparing to make a great moral issue of the matter and reform us in spite of ourselves.

New Haven, Conn. H. D. FISHER.

Measuring Coal

I read E. Ogur's article on "Measurement of Coal on Traveling Grates," which appeared in the Nov. 10 issue of *Power*. However, I must differ with him in his conclusions.

I have five 3,500-sq.ft. vertical water-tube boilers equipped with traveling-grate stokers burning anthracite culm. Six months ago I put on each grate a revolution counter and find that the counters check well with the car weights.

Our grates are 108 in. wide, and we carry a 4-in. opening of the coal-feed gate; one revolution of the grate shaft moves the grates 56 in. A sample of every car of coal is weighed, and I find that this always runs from 49 to 50 lb. per cu.ft. We always have a steady, smooth layer of coal passing under the gate, except that on rare occasions a lump may choke it, but the fireman, if he is on the job, will detect this pretty quickly.

For six months now car weights and my weights from this method have checked within 10 and 12 tons for the month. This method seems to show us pretty nearly what each grate consumes.

Wilkesbarre, Pa. THOMAS M. STREET.

Cooling Coils Submerged in Brine Tanks

Discussing methods for keeping ammonia vaporizing coils in refrigerating rooms free from ice, in *Power* of Oct. 6, R. L. Tullis offers the interesting suggestion that ceiling coils be surrounded with calcium-chloride brine contained in shallow pans or tanks likewise suspended from the ceiling of the room.

Such an arrangement might work well if but one tier of pipes were placed in each pan. Mr. Tullis' sketch indicates a coil three pipes in depth, and I venture the opinion that such arrangement would not yield the desired cooling effect unless the compressor were operated at very low back pressure, the area of brine surface not being adequate to receive the heat from the air of the room. Suppose, for an example, that the coils be of 2-in. diameter pipe, spaced 10 in. centers, and with sufficient surface to permit operation at 25 lb. gage back pressure, corresponding to vaporization of the ammonia at about 11 deg. F. The room may be held at about 34 deg., the temperature head between the ammonia and the air of the room thus being 23 deg. Each inch of length of one pipe exposes about 7½ sq.in. of surface to the air.

Let such a pipe coil, one tier in depth, be submerged in a shallow tank of brine, the tank being insulated on sides and bottom to prevent frost forming thereon. For every pipe there is at least 10 sq.in. of exposed brine surface per inch of pipe length, a surface increase of one-third as compared with pipe surface. However, the temperature of the brine must be a few degrees higher than that of the ammonia to which it is passing heat, perhaps six degrees at the least. The temperature head between air and brine is therefore only 17 deg., hence the heat transfer must take place through a surface increased in extent by one-third but with only about three-fourths of the temperature head afforded by bare, clean ammonia pipe. Perhaps the result might be satisfactory.

Suppose, now, that the coil be two tiers deep in the tank. There is now 10 sq.in. of brine surface to about 15 sq.in. of pipe surface. If the coil be three pipes in depth, the surface is as 10 to 22; that is, the brine surface is less than one-half of that required for the pipe and at the same time the temperature head is less. The small brine surface cannot receive the necessary quantity of heat unless it is a much better heat receiver than pipe surface, which may be doubted, not overlooking the possibility that the pipes may have a coating of frost or ice. If the heat-receptive surface be too small, a lower back-pressure must be carried, to do the required cooling, and this means increased daily cost of power. W. S. HUNTINGTON.

Atlanta, Ga.

Liquid Fuels from Coal

The writer of a recent series of articles in *Power*,[1] presented arguments to justify the use of low-temperature carbonization processes in America. He held that these could be economically installed in connection with central stations, which would burn the semi-coke while the byproducts would cover the cost of processing and provide profits. It would seem, however, that discussion of this subject has overlooked the tremendous influence that recent European researches may have on this whole problem of producing liquid fuels from coal.

Bergius, in Germany, fills a cylinder with a mixture of crushed coal and pitch and heats it to about a thousand degrees Fahrenheit while circulating hydrogen through the cylinder at about 2,000 lb. per sq.in. Up to 70 per cent of the coal has been converted into liquids by this hydrogenation process. The commercial success of the process seems to be dependent on cheap sources of hydrogen and on the market for liquid fuels.

Patart, in France, by catalytic methods at high pressure and temperature, converted water gas first into a mixture of hydrogen and carbon dioxide and then catalyzed this mixture into methanol. This is now made in quantity in Germany and has been shipped to this country at low prices.

Fischer, in Germany, has developed catalytic methods for converting heavy tars of low-temperature distillation processes into light motor fuels. He has also developed a catalytic process to convert water gas into a mixture of oils and alcohols which on refining produces a motor fuel called "Synthol." He has worked on still other catalytic processes that are not yet fully developed.

These are but the beginnings of extensive research developments that must ultimately affect our whole system of using and treating coal. The progress outlined has been substantial enough to indicate that one cannot properly approach a modern coal-distillation process without taking all these new developments under full consideration. Unfortunately, these processes have not been given the wide publicity that they deserve. Many people who are promoting development of carbonization processes will do well to study the new catalytic processes carefully and determine their effect on the processes they have in mind.

One cannot study these new processes without being impressed with the great amount of active research now carried on abroad and the small amount in this country. Surely, it is time our fuel technologists started some independent original research along these lines.

A. G. CHRISTIE,
Professor of Mechanical Engineering,
Baltimore, Md. Johns Hopkins University.

[1] Oct. 27 and Nov. 3 issues.

The Flush Front for Tubular Boilers

In the Oct. 27 issue L. L. Scheiderer had something to say on the subject of flush-front boilers. I wish to add that the flush front looks better because it is better in every way. Why should a fireman have to crawl under an extension-front boiler in order to attend to his fire? Such extensions are called "head bumpers," which seems to be a very appropriate name.

A substantial body of brickwork on the arch plate adds to the durability and life of the front. The convenience of the fireman may not be a vital point, but it is one on the right side. I have operated flush fronts for 47 years and am in favor of them without qualification. W. H. WAKEMAN.

New Haven, Conn.

Keeping the Power Plant Up to Date

The plant engineer, upon taking up a new position, often finds that the problem that confronts him is not what kind of new machinery is most suitable for his firm's needs, but getting his employers in the mood to purchase. Often an enterprising salesman pats himself on the back because of the excellent order he has in his pocket, quite unaware that the order is the result of months of pleading on the part of the engineer.

The engineer's life is not always a happy one. He may have an employer who takes for granted that the existing plant will last forever, and for the engineer to express a contrary view is looked upon as an expression of ignorance on his part, and consequently he cannot know his business. On the other hand, he may find himself with a firm which is not doing well financially, partly or wholly due to the obsolete plant in use; nevertheless new plants cannot be considered until "times are better."

Another type of proprietor frequently met with is one who claims some sort of engineering knowledge obtained away back in the dim ages, upon which his mind still loves to linger, and anything new which he knows nothing about is looked upon with suspicion.

These types are to be met with the world over, and the engineer who can successfully cope with them must, in addition to having full confidence in himself, carry a considerable amount of tact and possess a cool temperament. In dealing with a firm which has an "everlasting" plant, it is a good policy for the engineer to find out what competitors are doing, and continually pass this along to his firm in the form of news. It will in time produce the desired reaction, and he will be asked to submit a report on his requirements, and if he is in the position to supply a good deal of information as to what others are doing in addition to what he himself requires, he is pretty sure to get it.

With the second type, owing to financial restrictions the engineer must be guided by circumstances as they arise. When up against these conditions in a certain plant, I found it good policy to fasten upon any improvement that could be effected at a small cost and make the most of it. In due course I built up quite a modern plant, purchased to a large extent bit by bit out of the savings.

With the third type of proprietor mentioned, the engineer is compelled first to convince his employer that although he was once an engineer it is impossible to remain an up-to-date one without a good deal of study both of advertisements and technical matter that appears in the trade journals. Overcoming prejudices of the types mentioned, as with firms who back up the engineer at all times, is a matter that rests with the engineer himself, and whether he is worrying along with an old plant or has one that is modern it is for him to take the praise or accept the blame.

Belfast, Ireland. F. P. TERRY.

Steam-Driven Auxiliaries

It would appear that while M. Buckley's general thesis on steam-driven auxiliaries, which appeared in *Power* Nov. 10, to an extent is true, I believe the example he has chosen to prove his case is rather extreme, because it is not confined strictly to the issue in question.

For his auxiliaries in the so-called typical case chosen by him, he includes a number of items that may hardly be considered in that category. His list includes the following: Feed and condenser pumps; air compressor; elevator and service pumps; ice machine; stoker and fan. It is true that all these equipments may exist in a given plant, but the writer cannot see that it is fair to include them as plant auxiliaries.

In talking of the steam used by the auxiliaries in a power plant and determining the percentage of the steam so used compared with that used by the prime mover, it would seem to be fair to include only those things that are essentially a part of the plant operation. The air compressor would rarely be included, and we should not include the elevator or service pumps, and surely not the ice machine. These are units incidental to the particular establishment in which the power plant exists, but they are not part of the auxiliaries of the plant proper, which would include, generally speaking, boiler, feed pumps, stoker engine, stoker fan and possibly one or two additional minor items. If we take these units, we shall find that in almost any typical plant, the percentage of steam used by the auxiliary is a much lower figure than that cited.

While in general it is desirable to have an economical power plant and to keep the cost of running the auxiliaries as low as possible, there are other considerations to be kept before us. Many auxiliaries in power plants may be so designed that they can run at a constant speed, but included among those for which variable speed is highly desirable, are the forced-draft or induced-draft blowers. One of the last, if not the very last, of the auxiliaries in the plant to go to motor drive, is the forced-draft blower, because there are obvious and decided advantages in having variable-speed control, and nothing secures this so well as the use of steam power.

Another important element to be considered, is the matter of automatic regulation. Here again, especially in moderate-sized power plants, it is a simple matter to obtain automatic regulation with steam drive, whereas the use of motor drive makes automatic regulation a very delicate and at the same time, complicated matter, involving expensive equipment. By all means let us run elevators, service pumps, ice machines and so forth, by electrical drive, but let us not overlook the dominant advantage of convenient control and automatic regulation, which is afforded by the use of steam drive in the case of forced-draft blowers and other similar equipment. VICTOR H. CARPLES,

L. J. Wing Manufacturing Co.

New York City.

Newly Invented Thermometer Reads to 1,800 Deg. F.

Nine hundred degrees Fahrenheit is about the upper limit of temperature for which mercury-in-glass thermometers can be built. A few mercury-in-quartz thermometers reading up to about 1,300 deg. F. have been built in Germany. These contain gas under pressure to prevent the mercury from boiling. To obtain still higher temperature ranges, attempts have been made to use metallic tin, but this material did not prove suitable, as it freezes (that is, solidifies) when cooled to room temperature. For temperatures above 900 deg. F. it has been almost universal practice to use thermocouples or resistance pyrometers.

Considerable importance must therefore be attached to the announcement that a thermometer has been developed that is thoroughly practicable for temperatures as high as 1,800 deg. F. This thermomenter, which uses the metal gallium in a quartz bulb and stem, was developed at the Thomson Research Laboratory, General Electric Co., West Lynn, Mass., and described by Sylvester Boyer in the December, 1925, issue of *Industrial and Engineering Chemistry*. The power field, in common with other fields of science and engineering, will offer many applications for such a thermometer, so that the readers of *Power* will doubtless be interested in the following abstract of the article just mentioned.

Ever since fused quartz was invented its unusual properties, such as very low co-efficient of expansion and freedom from "set" after alternate cooling and heating, suggested it as an ideal material for thermometers, and particularly for thermometers to measure high temperatures. Mercury not being suitable for such high temperatures, the use of metals with low melting points immediately suggests itself. Such a metal is gallium, which melts at 85.5 deg. F. and boils at approximately 3,000 deg. F. Having once been melted, gallium may be under-cooled to about 34 deg. F. before solidifying.

The application of gallium to thermometers is not so simple as it might seem at first, and many difficulties have to be overcome. Heretofore the wetting of glass and quartz by liquid gallium has prohibited its use for thermometers, but a change in this property of the metal was observed when changing the gas pressure above the metal, increasing its purity, removing oxide and water film, and freeing it from absorbed or dissolved gases.

It is unnecessary here to go into the details of technique by which the gallium was purified and kept pure until the thermometer had been sealed. This has been accomplished in such a way that gallium has been made an ideal liquid for high-temperature thermometers.

The marking and calibration of the gallium-in-quartz thermometer presented several new and difficult problems. Finally, however, a protective coating of special composition was developed which permitted etching the marks with hot dilute hydrofluoric acid.

The etchings thus produced were satisfactory where accuracy alone was desired. For greater visibility it was necessary to develop a composition to color the etched marks. After some experimentation, it was found that sand and copper oxide in certain proportions would form a grayish black mark that was resistant to most chemical reagents and to heat-treatment at 1,800 deg. F.

The fixed points on the thermometer scales were determined by comparison with a thermocouple as standard or by direct comparison with certain well-known standards for temperatures.

A number of these thermometers have been made during the investigation and have functioned satisfactorily. Others have been loaned to various interested parties for tests.

In concluding his paper the author made acknowledgment to Berthold Niedergesass for many valuable suggestions concerning the method of filling and care of fused quartz, and also to Edward R. Berry for his continued interest in the investigation.

Hard Water—What It Is and What It Does*

By A. S. Behrman†

We may define the hardness of a water by saying that it is a "measure of calcium and magnesium compounds in the water." The compounds of sodium (soda) and potassium (potash), which are present in practically all natural waters, do not cause hardness.

It follows that water softening consists primarily in removing the calcium and magnesium from water. The two most general methods of effecting this result are: (1) Precipitation methods, typified by the lime-soda process, in which the calcium and magnesium are made to form insoluble compounds which form a sediment in the water and which can be removed by settling or filtration, or both; (2) the zeolite, or base-exchange method, in which the calcium and magnesium in the water are replaced with sodium, which does not cause hardness. In this process there is no precipitate or sediment formed.

Hardness of water is conveniently, though not entirely accurately, designated as either "temporary" or "permanent" hardness. By temporary hardness is meant the hardness that can be removed by boiling. The hardness of Lake Michigan water, for example, is almost entirely of the temporary variety; that of many coal-mine waters is largely permanent. The majority of waters have both kinds of hardness in varying proportions.

These two kinds are about equally objectionable in some of the industries—as in laundry work, for example. In others, as in the manufacture of raw-water ice, temporary hardness is particularly injurious; while in boiler-feed waters permanent hardness is the more undesirable.

In the boiler plant hard water is chiefly objectionable because of the deposit or scale it forms on the boiler tubes. Scale is an excellent insulator. This means that it is more difficult and requires more fuel to heat the water in or around the tubes. The coating of scale also makes it easy for tubes to overheat and to sag or burn out. The annual losses in fuel alone, due to scaly boilers are huge.

In the manufacture of raw-water ice, hard water, particularly water with temporary hardness, makes ice of inferior quality, increases the cost of production and lowers plant capacity.

In the textile and dyeing industries hard water precipitates certain dyes, giving a spotty and inferior product.

Since we have defined hardness as a measure of the calcium and magnesium compounds in water, it is evident that a chemical analysis of the water is the most accurate way of determining the hardness. A chemical analysis is a pretty lengthy procedure, however, and for many purposes we can secure a sufficiently accurate result by the "soap test."

The Soap Test

The "soap test" consists simply in finding out how much soap a given water requires to form a lather. Naturally, the harder the water the more soap will be required. If, then, we take a measured sample of the water in a bottle and add to it a soap solution of a certain definite strength—that is, a "standard solution"—a little at a time, shaking the bottle after each addition until a lather is formed, we can calculate from the amount of soap solution used the hardness of the water.

It is convenient to report all compounds of calcium and magnesium in terms of their equivalents in one of these compounds—just as it was convenient for some of the Indian tribes to refer the values of different commodities to a unit commodity, such as a horse or rifle. For this purpose the compound calcium carbonate (limestone) is employed.

The amount of hardness in water is usually reported either in the metric system as "parts per million"—that is, parts of calcium carbonate (or its equivalent) per million parts of water—or in the English system as grains per gallon—that is, grains of calcium carbonate equivalent per gallon of water. One grain per gallon (U. S.) is equivalent to 17.1 parts per million; or reciprocally, one part per million equals 0.0584 grain per gallon.

During the fiscal year ended June 30, 1925, the Bureau of Standards, Department of Commerce, completed 173,261 tests, according to a report to Secretary Hoover. This represents a considerable increase over previous years; 115,729 tests having been completed in 1923, and 135,852 in 1924. The fee value of the work is $547,543.35. This is also an increase over past years, the 1923 and 1924 figures being $419,915.70 and $509,850.87, respectively. A great variety of materials and devices were tested, and almost every industry and branch of the government has been served by the Bureau.

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*Abstract of article in the October issue of the International Filter Company's house publication.

†International Filter Co.

Recent Publications

Power Plant Lubrication. By William Farrand Osborne. Published by McGraw-Hill Book Co., Inc., New York City. Cloth; 6 x 9 in.; 262 pages; 84 illustrations. Price, $3.

Probably no single branch of engineering has been so surrounded by mystery as has lubrication. Whether this be a traditional attitude from the old days of the fake Indian selling oil for aches and pains, is not known, but certainly it is practically impossible to obtain direct data on the proper oil and the correct application to be used on a given machine. This volume endeavors to tell the power-plant engineer the essential facts about lubricating oil. It should find a ready sale for it bears the earmarks of a serviceable volume.

The Oil Industry and the Competitive System; A Study in Waste. By George Ward Stocking, assistant professor of economics, Dartmouth College. Published by Houghton Mifflin Co., 2 Park St., Boston, Mass. Cloth; 5¼x8 in. Price, $3.50.

This comprehensive study of the oil industry is one of the series of prize essays on economics which owes its existence to the generosity of Messrs. Hart, Schaffner & Marx, of Chicago. The book, while not contributing much new material to the subject of the oil industry and the enormous waste connected with its present operation, is a serious contribution to oil bibliography, as it gathers together and correlates much information that was scattered throughout many government departments, and so serves an exceedingly useful purpose.

Industrial Electricity, Part II. By Chester L. Dawes. Published by McGraw-Hill Co., Inc., New York, 1925. Cloth; 5½x8 in.; 480 pages; 355 illustrations. Price, $2.75.

In a previous volume the author treated of direct-current circuits and equipment under the title, "Industrial Electricity, Part I," of which this book is a companion volume and deals with alternating-current circuits and equipment. Although a theoretical treatment of the subjects is given, only the simplest mathematics is used. Four of the 14 chapters are devoted to fundamental principles to provide a foundation for the study of the other chapters dealing with alternators and their characteristics; instrument and electrical measurements; transformers; polyphase induction motors; single-phase motors; synchronous motors and converters; transmission and distribution; illumination; electron tubes; and interior wiring. Many problems are given that apply to the subjects discussed in the various chapters; there are also included tables and trigonometric formulas such as are required in working out the problems in the text. In the explanation of the various principles, examples are worked out to show how these are applied to practical problems. The book is intended as a text for use in classrooms, but the treatment is such as to make it suitable for home students who understand plane trigonometry and who wish to improve their knowledge of alternating-current circuits and equipment.

The Case of Bituminous Coal. By Walton H. Hamilton and Helen R. Wright, with the aid of the Council and Staff of the Institute of Economics. Published by the Macmillan Co., New York City. Cloth; 5x7½ in. 310 pages. Price, $2.50.

Into the coal situation this book, with a touch of humor which streaks an otherwise dark and sooty subject, has been injected. It is frankly an attempt to analyze the "mess." The editors have assiduously read all the available material on the subject of bituminous coal and have served it concisely up with a good humorous sauce. A promise is made in the Director's Preface that there is to be another volume on coal which will be constructive. There is much in this volume which shows the necessity for arriving at an understanding and for stabilizing the coal industry which should be of particular interest to the power-plant field. One such passage is:

> There seems to be no current substitute capable of supplying large enterprises. The hydro-electric industry will probably advance, but its expansion is hedged about with natural barriers. If all the water-power in the country were harnessed, and if it were by some quite wasteless process turned into industrial energy, it would not suffice to keep current industry going. To a limited extent the fall of water can replace coal; but the inaccessibility of water power, the expense in equipment necessary to its utilization, and the waste incident to its conversion and transmission give an immediate chance for a very partial substitution. Even the promise of superpower, which just now seems to lurk ominously in the offing is nothing more than to make a ton of bituminous go farther. If, with the lapse of years and the expansion of industry, our demand for power should increase, our current knowledge can point to no other source than coal.
>
> Nor does a developing technology give any future assurance of a rival source of industrial energy. The waves, the tides, the rays of the sun, the atom may well hold stores of energy that dwarf even our reserves in bituminous coal. But the scientific formulas which will unlock these reservoirs and turn them to account have not yet been discovered.

Wassermessungen bei Wasserkraftanlagen. (Measuring Water Flow to Hydraulic Turbines). By Dr. Ing. L. A. Ott. Reprinted in German from Wasserkraft Jahrbuch, 1924 (Water Power Yearbook). Published by Profs. Dantscher and Reindl, Munich, Germany. Paper, 7½ in. x 9 in.; 26 pages; 15 illustrations.

This treatise discusses the eleven methods of water-flow measurement in closed and open channels outlined in the British Standard Test Code for Hydraulic Power Plants. More accuracy is claimed for the various types of screw-propeller meter wheels employed in the penstocks of high-head water wheels in Scandinavia, Germany and Switzerland. Mathematical and graphical methods of obtaining the rate of flow from measurements of the velocity at several points in the cross diameters of pipe lines are given. Actual results of tests and daily observation are plotted in curves. The many refinements in shaping the blades, calibration, mounting and fixing the propeller meters in the lines of notable European installations are illustrated and described. As this method of flow measurement is new in America, the treatise will doubtless prove interesting to hydraulic engineers.

Die Oelfeuerung (Oil Firing). By Bruno Schulz, formerly Chief Naval Architect in the German Navy. Published by W. Knapp, Halle, Germany, 1925. Paper; 6½x9¾ in.; 197 pages; 104 illustrations; numerous tabulations.

While principally devoted to marine practice, this book contains many interesting features regarding the development of oil firing from the earliest attempts in the sixities to the latest oil-burning equipments in use on board American, English and German ships. All of the better known types of burners, air registers, heaters, filters, meters and oil handling and storage systems in the three respective countries are illustrated and described. Practical suggestions on the design, operation and care of oil-fired boiler furnaces are given, which include protective measures against fire. The last chapters are devoted to the chemical and physical properties of fuel oils and the commercial aspects of oil firing under stationary and marine boilers.

Bituminous Coal Fields of Pennsylvania; Coal Analysis. Prepared by the United States Bureau of Mines, published by the Commonwealth of Pennsylvania, Department of Forests and Waters, as Topographic and Geologic Survey, Bulletin M 6, Part IV. Copies may be obtained free by applying to the Pennsylvania Topographic and Geologic Survey, Harrisburg, Pa.

An Investigation of Certain Methods for Testing Heat Insulators, by E. F. Grundhofer, is Bulletin No. 33, published by the Engineering Experiment Station of the Pennsylvania State College, State College, Pa. An extensive "Bibliography of Heat Transmission," relating principally to insulating and building materials, is also contained in this bulletin.

Directory of Manufacturing Establishments, State of Iowa, 1924. Issued by the Bureau of Labor, A. L. Urick, Commissioner. Published by the State of Iowa, Des Moines, Iowa. This publication, Bulletin No. 16, gives in detail by towns and cities and also by industries the manufacturing establishments in the state.

The 1925 Report of Committee D-2 on Petroleum Products and Lubricants of the American Society for Testing Materials. This is a reprint of the society's standards and tentative standards on petroleum products and lubricants.

A Treatise on Missouri Clays, by Martin Harmon Thornberry. Bulletin issued by the School of Mines and Metallurgy, University of Missouri, Rolla, Miss.

Columbia Power Station Near Cincinnati Dedicated on December 10

Station Formerly Called Miami Fort Plant Has 90,000-Kw. Capacity

A SPECIAL train carried fifty outstanding financiers, utility executives and engineers from New York City to participate in the dedication exercises of the new Columbia Station of the Columbia Power Co. at Cincinnati, Ohio, Dec. 10. The ceremony was attended by eight hundred guests.

The program of the dedication included addresses by W. W. Freeman, president of the Union Gas & Electric Co.; Philip Geier, president of the Cincinnati Chamber of Commerce; Charles D. Jones, president of the Cincinnati Gas & Electric Co.; J. M. Hutton, president of the Cincinnati, Newport & Covington Light & Traction Co.; Owen D. Young, chairman of the Board of Directors, General Electric Co., Philip G. Gossler, president of the Columbia Gas & Electric Co.

Mr. Freeman outlined the growth of the Union Gas & Electric Co. saying that the output had increased tenfold in ten years, that there had been $43,000,000 invested during this period, and that the average rates decreased owing to growth in load in spite of increased costs. Mr. Young emphasized the increased power today behind the worker, enabling industry to meet foreign competition. Seven billion dollars investment in electric utilities, he stated, had a gross revenue this year of one and one-half billion dollars. He believed that the diversity in ownership was an insurance against abuse of power in systems. Mr. Gossler spoke on the service rendered the community by the Columbia system, outlining its organization, composed of three thousand stockholders including 75 per cent of the employees.

After the exercises Virginia Junggren, daughter of Oscar Junggren, designer of the turbines, turned on the throttle. Charles T. Taft, representing the Board of Directors, then threw the switch which put the station on the system.

Following the dedication a luncheon was served and the visitors were taken on an inspection trip through the plant.

At the banquet in the evening, addresses were made by prominent men. The program of the banquet was broadcasted.

The guests were also conducted on an inspection trip to the West End Power Station of the Union Gas & Electric Co. and to the Millers Ford Station near Dayton. Thus completing a three-day tour of the three large generating plants of the Columbia system.

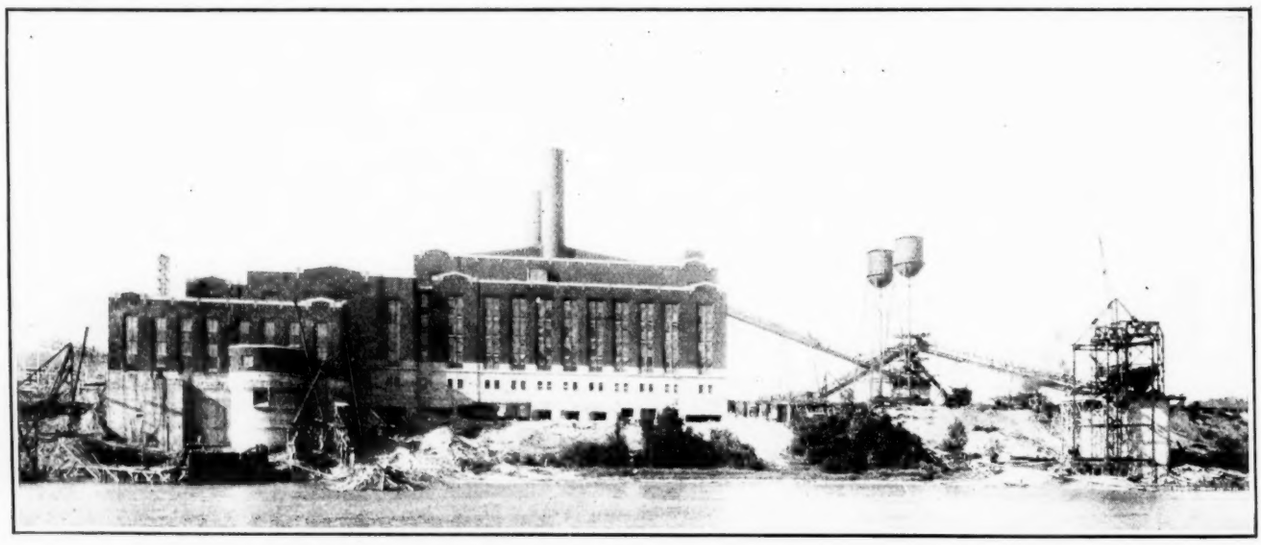
Features of New Plant

The new station, a preliminary description of which appeared in the Dec. 30, 1924, issue of *Power*, is located at the confluence of the Ohio and the Big Miami Rivers, west of Cincinnati and near the site of the historic Miami Fort. The initial capacity is 90,000 kw., furnished by two 45-kw. tandem-compound turbo-generators. The outstanding features of the station include a high steam pressure, 600 lb. and 725 deg., reheating of the steam between the high- and low-pressure sections of the turbines, pulverized coal, air preheaters and stage bleeding for heating feed water on the regenerative cycle. While these features have been used independently in other stations, this is the first station to combine all of them. Provision has been made for the ultimate installation of eight turbo-generators as the load demands.

The station was designed by Sargent & Lundy, of Chicago, under the supervision of C. W. DeForest, vice-president of the Columbia Power Company.

Grasselli Medal Conferred on Dr. Berry

Dr. E. R. Berry, assistant director of the Thomson Research Laboratory of the G. E. Co., has announced the development of a new thermometer that will record temperatures up to 1,800 deg. His announcement follows the receipt by him of the Grasselli Medal from the American section of the Society of Chemical Industry. The new thermometer is made possible through the development by Dr. Berry of fused quartz. The material that will replace the mercury is metallic gallium. It is expected that the new thermometer will be able to measure accurately heat twice as great as can be measured by the best mercury thermometer. A description of the new thermometer is given on page 952 of this issue of *Power*.



New Columbia Steam Plant of the Columbia Power Company

Moscow Has New Power Plant in Operation

The newly completed power plant at Shatura, near Moscow, Russia, was dedicated on Dec. 5. This plant of 65,000 hp. represents the first plant of any considerable size so far erected in Russia. Leon Trotsky in speaking at the dedication ceremonies, said that the using of American transmission towers in this system would at least establish electric-diplomatic relations with the United States.

Leather Belting Exports Increase in 1925

Leather belting amounting to 1,088,295 lb., valued at $1,583,517, was exported from the United States in the first 10 months of 1925, representing an increase of 20.8 per cent in quantity and 16.8 per cent in value over the trade in the corresponding period of 1924. The principal markets to which increased quantities were shipped compared with the 1924 period, the amount exported to each, and the respective increases are as follows: China, 142,941 lb., 10 per cent; British India, 130,259 lb., 42 per cent; Canada, 129,636 lb., 90 per cent; Mexico, 113,240 lb., 35 per cent; Cuba, 112,412 lb., 3 per cent; and South America, 165,340 lb., approximately 9 per cent. Shipments to the United Kingdom, Japan, and British South Africa, which were, respectively, 59,749, 8,951, and 22,437 lb., registered declines.

Petroleum Research Aided by John D. Rockefeller Gift

John D. Rockefeller has pledged a fund of $250,000 to the American Petroleum Institute "for the initiation of a program of scientific research in petroleum," according to an announcement made last week by the American Petroleum Institute. The fund is to be available in annual installments of $50,000 for five years, and to be expended "primarily in supporting research fellowships in scientific institutions—the recipients of such fellowships to engage in research on some problem of the physics, chemistry or geology of petroleum oil"; and the results of the work are to be made "freely available to the industry and public generally."

The purpose of this program is not merely to secure the carrying on of a limited amount of scientific research by specially engaged workers, but rather to utilize this means to enlist a more general scientific interest in petroleum. It is therefore left to the discretion of the committee administering the fund to employ it not only for the direct support of research, but in any other manner which will accomplish Mr. Rockefeller's major purpose.

Mr. Rockefeller recommends that the fund be administered by a committee consisting of Messrs. J. C. Donnell, Walter C. Teagle and Robert L. Welch, all directors of the American Petroleum Institute. Mr. Donnell is president of the Ohio Oil Co.; Mr. Teagle is president of the Standard Oil Co. of New Jersey; and Mr. Welch is general secretary and counsel of the Institute.

President's Message Considers Subjects of Interest to Nation's Power Development

Subjects Taken Up Include Coal, Muscle Shoals, St. Lawrence Waterways —Colorado River and Reorganization of Executive Department

THE PRESIDENT, in his message to Congress on the state of the Union, delivered on Dec. 8, besides reporting on the general condition as being one of progress and prosperity, has taken up in a detailed way the various questions being considered by the federal government. He has some things to say of direct interest to the power-plant field. His statement on Muscle Shoals, which was awaited with interest, is as follows:

Muscle Shoals

The problem of Muscle Shoals seems to me to have assumed a place all out of proportion with its real importance. It probably does not represent in market value much more than a first-class battleship, yet it has been discussed in the Congress over a period of years and for months at a time. It ought to be developed for the production of nitrates primarily, and incidentally for power purposes. This would serve defensive, agricultural and industrial purposes. I am in favor of disposing of this property to meet these purposes. The findings of the special commission will be transmitted to the Congress for their information. I am convinced that the best possible disposition can be made by direct authorization of the Congress. As a means of negotiation I recommend the immediate appointment of a small joint special committee chosen from the appropriate general standing committees of the House and Senate to receive bids, which, when made, should be reported with recommendations as to acceptance, upon which a law should be enacted, effecting a sale to the highest bidder who will agree to carry out these purposes.

If anything were needed to demonstrate the almost utter incapacity of the national government to deal directly with an industrial and commercial problem, it has been provided by our experience with this property. We have expended vast fortunes, we have taxed everybody, but we are unable to secure results which benefit anybody. This property ought to be transferred to private management under conditions which will dedicate it to the public purpose for which it was conceived.

Coal

The President, besides stating the condition of the coal industry, says:

At the present time the national government has little or no authority to deal with this vital necessity of the life of the country. It has permitted itself to remain so powerless that its only attitude must be humble supplication. Authority should be lodged with the President and the Departments of Commerce and Labor giving them power to deal with an emergency. They should be able to appoint temporary boards with authority to call for witnesses and documents, conciliate differences, encourage arbitration, and in case of threatened scarcity exercise control over distribution. Making the facts public under these circumstances through a statement from an authoritative source would be of great public benefit. The report of the last coal commission should be brought forward, reconsidered and acted upon.

Waterways Development

On the waterway development besides other questions he has this to say:

Two other main fields are under consideration. One is the Great Lakes and St. Lawrence, including the Erie Canal. This includes stabilizing the lake level, and is both a waterway and a power project. A joint commission of the United States and Canada is working on plans and surveys which will not be completed until next April. No final determination can be made, apparently, except under treaty as to the participation of both countries. The other is the Mississippi River system. This is almost entirely devoted to navigation.

In regard to the development of the Colorado River, the President, after outlining the efforts of the government and summarizing the action of the states with regard to the compact, continues:

There appears to be no division of opinion upon the major principles of the compact, but difficulty in separating contentions as to methods of development from the discussion of it. It is imperative that flood control be undertaken for California and Arizona, preparation made for irrigation, for power, and for domestic water.

Some or all of these questions are combined in every proposed development. The federal government is interested in some of these phases, state governments and municipalities and irrigation districts in others and private corporations in still others. Because of this difference of view it is most desirable that Congress should consider the creation of some agency that will be able to determine methods of improvement solely upon economic and engineering facts, that would be authorized to negotiate and settle, subject to the approval of Congress, the participation, rights, and obligations of each group in any particular works. Only by some such method can early construction be secured.

Water Power

On water power the message contains recommendations for increasing interconnection between power plants, or superpower, as follows:

Along with the development of navigation should go every possible encouragement for the development of water power. While steam still plays a dominant part, this is more and more becoming an era of electricity. Once installed, the cost is moderate, has not tended greatly to increase, and is entirely free from the unavoidable dirt and disagreeable features attendant upon the burning of coal. Every facility should be extended for the connection of the various units into a superpower plant, capable at all times of a current increasing uniformity over the entire system.

Reorganization

No final action has yet been taken on the measure providing for the reorganization of the various departments. I therefore suggest that this measure, which will be of great benefit to the efficient and economical administration of the business of the government, be brought forward and passed.

Petroleum Production and Stocks Decline in October

The production of crude petroleum in the United States, as reported to the Bureau of Mines, for the month of October, 1925, amounted to 64,273,000 bbl., a daily average of 2,073,000 bbl. This represents a decrease from September production of 84,000 bbl. a day, or 4 per cent, which is the most acute drop in production for any month of the year. Decreased production in Oklahoma—the influence of the Garber field not yet being felt—and in California was responsible for most of the decreased production.

Crude-oil stocks east of California amounted to 298,110,000 bbl. on Oct. 31, 1925. This represents a decline during the month of almost 3,000,000 bbl.—the fifth successive month in which there has been a decline in these stocks.

Production and stocks of lubricants showed comparatively little change, a decrease in home consumption being compensated by an increase in exports.

Public Service Commission of Pennsylvania Reports on Conowingo Project

Commission Withholds Its Approval of Petition and Suggests Modified Financial Setup—Philadelphia Electric Co. Accepts Modifications

THE Public Service Commission of the Commonwealth of Pennsylvania, in a report made public in Harrisburg during the past week, defined the financial ramifications of the Conowingo hydro project of the Philadelphia Electric Co. on the Susquehanna River. The financial part of this project has been protested by the Philadelphia Rapid Transit Co., one of the principal customers of the Philadelphia Electric Co.'s power, as not being feasible. The report says in part:

> It is clear to the commission from the check it has made of the various engineering estimates submitted, and other matters of the voluminous record presented, that the benefit to the public and to the Philadelphia Electric Co. will depend upon amendments to be made in accordance with the principles laid down in this report.

A most persuasive feature of the project, to the commission, is the fact that it would be of great value in the conservation of natural resources, as the initial installation is estimated to result in an annual saving of 604,000 tons of coal, which may be increased later to a saving of 1,000,000 tons yearly.

The concrete dam would form a pool that would be chiefly in Pennsylvania, and the water would operate seven hydro-turbine units of 43,000 hp. each, the electric energy to be transmitted from Maryland to Philadelphia by 220,000-volt transmission lines.

After discussing the case in some detail, the commission's report stated:

> In our judgment, it is in the public interest to afford the applicants an opportunity to modify the contracts in accordance with the foregoing principles before we finally dispose of the applications.

> The risk and burden of necessarily increased costs of construction should be borne by the consumers, and the benefit of decreased costs of construction should likewise, go to them.

The modification required provides for a provision for payment of 7 per cent of the actual legitimate investment instead of the so-called rental as it effects a stand-by charge and energy rates in the lease agreements.

The Class A stock should be eliminated and provision made that, without the consent of the Federal Power Commission, and the Pennsylvania Commission, the Susquehanna Water Power Co. shall not dispose of the ownership of the Susquehanna Power Co., nor shall the Philadelphia Electric dispose of the ownership of the stock of the Susquehanna Electric Company.

Another provision required is one prohibiting the Susquehanna Water Power Co. to issue preferred stock with a dividend rate of more than 8 per cent. The coal clause must be eliminated.

The commission also will require the Philadelphia Electric and the Susquehanna Water Power Co. to stipulate that they will cause two Maryland applicants to keep books, records and other data relating to the project, and to produce them upon request of the commission, to allow any representative of the commission to have access to the records, and also to the dam, power house and other property of the Maryland companies.

The report shows there was wide diversity of opinion between the applicants and the Philadelphia Rapid Transit Co., the protestant, regarding the project's cost, its capacity and output. The applicant's cost estimated was $52,220,000, which is exclusive of the Philadelphia Electric Co.'s investment to prepare the energy for distribution, estimated at $11,193,000.

The total structural cost is given at $34,337,450, and the total overhead and contingencies at $17,882,550.

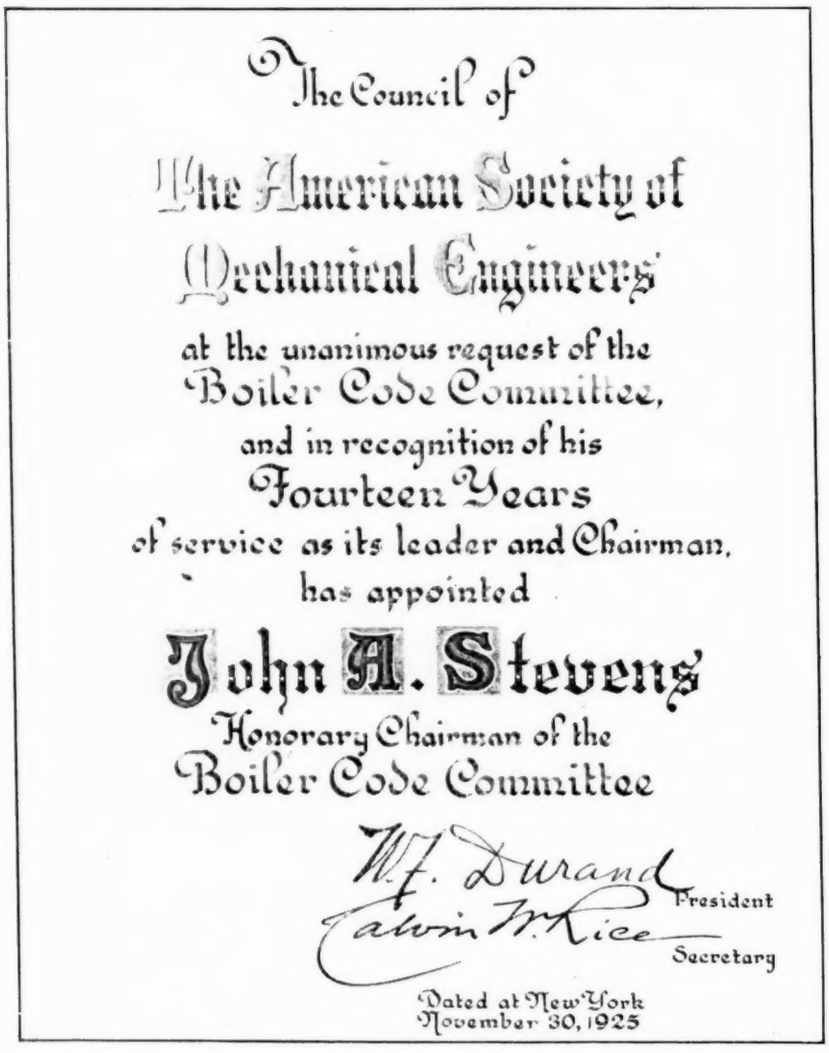
After discussing the pre-license or preconstruction costs, including $2,921,583 for the purchase of the capital stock of the Susquehanna Power Co., on which Drexel & Co. hold an option, and the $1,170,000 fee for surrender of the Drexel option, the commission stated:

> The protestant made no estimate of the cost of the project. The commission, after a careful check of the applicant's figures, is of the opinion that the actual investment in the project should not exceed the sum of $52,220,000, and, in fact, should be reduced to less than that amount.

The applicant's engineers estimated that there can be delivered from Conowingo and absorbed in 1930 by the Philadelphia Electric Company 1,150,000,000 kw.-hr., while the protestant's engineers said this estimate should be 1,025,220,000 kw.-hr.

The applicants estimated the saving in steam-plant construction will amount to 189,800 kw. at $148 a kw. and the protestant estimated the saving at 100,000 kw. at $115 per kw.

The Board of Directors of the company at its meeting on Dec. 7 accepted the suggestions of the Public Service Commission relative to the modifications of the application in connection with the Conowingo project.



At the recent meeting of the A.S.M.E. the council of the society rendered the above testimonial to John A. Stevens in recognition of his great service to the Boiler Code Committee as its active chairman for fourteen years. He is now honorary chairman and Fred R. Low, past-president of the society, has assumed the duties of active chairman

Miniature Power Plant Built by Yale Students

Under the auspices of the Yale branch of the A.I.E.E., undergraduates of the electrical engineering courses of the university arranged a unique exhibition.

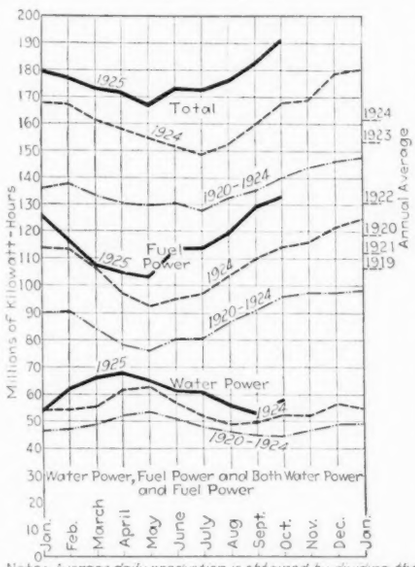
It was held in the Dunham Laboratory on Dec. 11 and 12 and was entirely extra curriculum work for the students, every one of whom selected a specific exhibit and used his own ingenuity in working it out.

On the ground floor of the laboratory was constructed a miniature power plant, new motors, motor controls and a motor that acted like a bucking broncho. On the upper floors the students went in for fun and mysticism with eggs that poach over a cake of ice, a golf course, an automatic telephone exchange, trick colored lightning, a miniature electric train and substation and radio and telegraphic freaks.

The industrial motor and high voltage are of keen interest to the plant engineer and professional visitors. Both individual ingenuity and also group co-operation were displayed.

Central Station Output Greater Than Ever

The average daily production of electricity by public-utility power plants in October was 191,300,000 kw.-hr.



Note: Average daily production is obtained by dividing the total for the month by the number of days in the month

Central Stations, Electric Railway Plants, and output of other Plants Generating Electricity for Public use

More electricity was generated by public-utility power plants in the United States in October than ever before.

The average daily production for each month in this year by public-utility power plants and the proportion produced by water power were as follows: Jan., 179,700,000, kw.-hr., 30 per cent; Feb., 178,600,000 kw.-hr., 35 per cent; March, 173,900,000 kw.-hr., 38 per cent; April, 172,700,000 kw.-hr., 39 per cent; May, 169,000,000 kw.-hr., 39 per cent; June, 174,800,000 kw.-hr., 35 per cent; July, 175,500,000 kw.-hr., 35 per cent; Aug., 176,200,000 kw.-hr., 32 per cent; Sept., 182,800,000 kw.-hr., 29 per cent; Oct., 191,300,000 kw.-hr., 30 per cent.

Citizens Send Open Letter to Anthracite Operators and Miners

Engineers and Economists Voice Their Beliefs Concerning Improved Methods

AN OPEN letter addressed to the coal-mining industry, operators and miners, by forty eminent citizens, engineers and economists, has been made public during the past week. It was as follows:

Anthracite Operators Negotiating Committee, Major W. W. Inglis, chairman; United Mine Workers of America, John L. Lewis, president:

The uninterrupted mining and distribution of coal has become essential to our national welfare. Periodic suspensions of these services menace the well-being of the entire community. This is the warrant for this open letter addressed by a group of disinterested citizens—engineers and economists—to you, who are primarily concerned with the conduct of the anthracite industry.

We believe that the responsibility for maintaining an uninterrupted and effective supply of anthracite coal rests upon you, operators and miners, jointly. Your inability to reach agreement on the issues confronting you indicates, not that you do not appreciate this joint responsibility, but that you have not yet perfected a method for meeting it as the public interest requires.

We believe that the demands of the miners and the position of the operators, as publicly stated by you, are but the symptoms rather than the causes of this latest of a series of stoppages; that the real causes lie in the basic economic and technical organization of the industry.

We believe that no agreement will insure continuity of production and distribution in the future which fails to provide a continuing joint agency which will concern itself, not so much with the adjustment of grievances, as with the constructive consideration of the underlying economic and technical facts by which all questions of wages, working conditions and earnings must in the end be determined.

Observation and experience convince us that joint effort on the part of management and workers in improving methods of production and distribution can increase wages and lift and stabilize earnings at the same time that they lower the price to the consumer. The constructive results of such joint effort would, we believe, be of far larger importance both to you and to the consumers of anthracite than the mere temporary settlement of symptomatic grievances.

We submit that the present price of anthracite and the recurring interruption of its production constitute a challenge to you jointly to grapple with these fundamental problems of economic and technical organization.

SIGNED BY:

Frank H. Dixon	W. H. Leffingwell
Sanford E. Thompson	L. P. Alford
Robert T. Kent	Harrington Emerson
Irving Fisher	Frank A. Fetter
Dwight T. Farnham	A. B. Wolfe
Fred J. Miller	John A. Ryan (Rev.)
John H. Gray	Percy S. Brown
Hugo Diemer	Charles R. Stevenson
Dexter S. Kimball	Morris L. Cooke
H. V. R. Scheel	Keppele Hall
Wesley Mitchell	George E. Barnett
Walter F. Rittman	William O. Wayforth
Ira N. Hollis	Henry R. Seager
Joseph W. Roe	Samuel McC. Lindsay
Harlow S. Person	Francis Lee Stuart
John H. Williams	Royal Meeker
Jacob H. Hollander	Wallace Clark
Robert W. Bruers	Edwin R. A. Seligman
Ernest M. Patterson	Fred R. Low
William R. Basset	Hudson B. Hastings

The anthracite operators replied to the economists that they agree with them. The operators' letter in part is as follows:

We entirely agree that so far as our industry is concerned, the need is for "constructive consideration of the underlying economic and technical facts by which all question of wages, working conditions and earnings must, in the end, be determined."

The basis of consideration you propose, namely, one of facts which will take into account all economic, industrial and commercial factors, has our hearty assent. The ideals you express are upheld by the findings of the United States Coal Commission, which said in effect that what was needed was more dependence on facts and less on force. It is for the maintenance of this principle that we have been contending from the beginning of the present dispute.

Experiment With Pulverized Lignite on Locomotive

The news that lignite may be adopted for fuel in the engines of the International-Great Northern Railroad, replacing crude oil, will be of interest to the power-plant field. One of the engines is now being equipped in the Texas shops for burning lignite experimentally and it will be placed in service soon. Results will be watched with interest.

Several other large industries in Texas are arranging to substitute pulverized lignite for oil for fuel. Among these is the electric power plant which the Comal Power Co. is constructing near New Braunfels.

Colorado River Hearings Open Promptly

Hearings on the Colorado River problem began on the first day of Congress before the Committee on Irrigation and Reclamation. Notice that the State of California stands ready to pay the entire cost of construction of a dam at Boulder Canyon if it could have the right from Congress was served by Hiram Johnson, Senator from California. Mr. Johnson told his colleagues on the committee that neither California nor the City of Los Angeles, both of which favor the Boulder Canyon dam project, embodied in the Swing-Johnson bill, are asking a favor of the federal government, and only the fact that there is no way by which they can be authorized to undertake the project has led to the demand for Congressional action.

Mr. Larue, engineer of the Geological Survey, who has made extensive surveys of the Colorado River, is opposed to the Boulder Canyon dam and recommends that 13 dams be built on the river, and that the government should immediately build a flood-control dam at Mohave on the lower river.

O. C. Merrill's testimony was confined almost entirely to the height of the dam in Boulder Canyon which would be best suited to the development of power and at the same time contribute to flood control. Mr. Merrill, executive secretary of the Federal Power Commission, is to be recalled to present a plan for financing the project. He is opposed to the Swing-Johnson bill, but in case Congress should approve federal participation, he has worked out a plan whereby the government can lend its credit to the project without money from the Treasury.

Large Submarine Cable Helps Sweden Export Power

The largest submarine power cable ever laid has enabled Sweden to add electricity to its exports. The cable was laid this fall under the Baltic from Helsingfors, Sweden, to Elsinore, Denmark. It brings power at 50,000 volts from the River Lagan, in southwestern Sweden, to Copenhagen, the Danish capital, where it is used by utility companies and factories. The entire countryside about Copenhagen is lighted by Swedish power, and plans are being considered for extension of this service to other European countries.

Swedish Government experts have estimated the country's power resources at nearly 100,000,000,000 kw.-hr. per year. Regulation of rivers and utilization of lakes as reservoirs would make available for use about 32,500,000,000 kw.-hr. of this total. This is an average of 5,000 kw.-hr. for every inhabitant, making Sweden in this respect one of the most favored nations in Europe.

Congress Probably Will Not Be in Sympathy with President's Muscle Shoals Program

Both Senate and House Are Expected To Take Their Time for Consideration

CONGRESS is going to be in no hurry to take up the disposition of the government's Muscle Shoals properties. This has been indicated on each side of the Capitol. Senator Watson of Indiana goes so far as to predict that there will be no legislation at this session. While it is recognized that there is much valuable material in each of the reports made by the Muscle Shoals Commission, the consensus of opinion seems to be that the reports are not likely to change any votes.

The President's reference to Muscle Shoals in his message to Congress is expected to exert a profound influence on public opinion, but it will take time for that fact to become evident. In the meantime it is assumed that Congress would not be ready at this time to go as far as the President suggests.

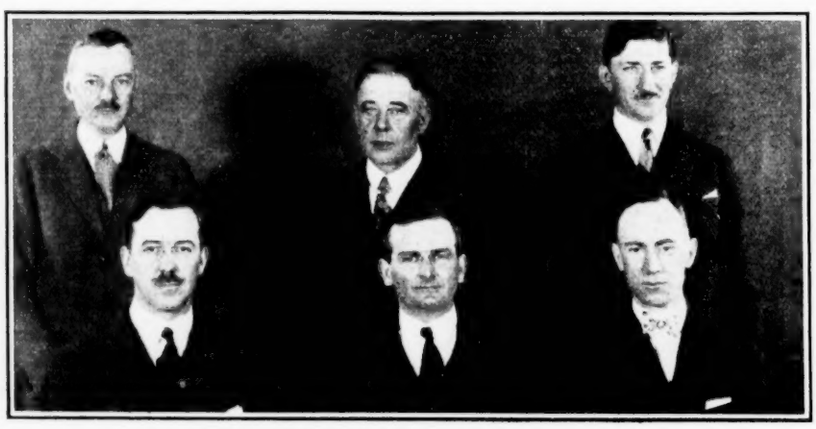
From the definite way in which the President condemns public operation, it is assumed that he would veto any legislation containing such a proposal, which makes it the more certain that no such plan can be put through. The evident feeling displayed in his reference to the incapacity of the government to deal with an industrial and commercial problem is thought to have been prompted by his experience with the shipping board. It is thought that he has visualized the much greater difficulties that would surround a government foray into the fertilizer business.

In connection with the President's recommendation for the outright sale of the properties it is understood that fully two-thirds of the government outlay can be obtained for the properties from those who are familiar with the conduct of the enterprises that best can be conducted there. Apparently, the power industry, the fertilizer industry and the majority of the people in the South are favorably impressed with the President's recommendation, although there is no great hope that Congress will accept them at this session.

A. S. M. E. Plans Western Tour in Spring

Plans are being made for a special A.S.M.E. tour in connection with the spring meeting to be held at San Francisco in 1926. A special all-Pullman train will leave New York on June 14, and will arrive at San Francisco on June 27, by way of Chicago, Kansas City, Denver, San Diego and the Yosemite National Park.

The return trip will be by way of Puget Sound, the Canadian Rockies, Winnipeg, Minneapolis and St. Paul, Chicago, Detroit and Niagara Falls, with arrival in New York about July 13. Numerous side trips and receptions will mark this 3,500-mile tour, and it will be a remarkable opportunity for engineers to see a vast amount of the country.



The A.S.M.E. Local Sections Committee

Standing, left to right—James D. Cunningham, Chicago; Col. Paul Doty, St. Paul; Ernest Hartford, Sec., New York City. Seated, left to right—Prof. James A. Hall, Providence; Charles Penrose, chairman, Philadelphia; W. A. Henley, Indianapolis.

Obituary

Henry Niederauer, for thirty years chief engineer and plant superintendent of the Boston (Mass.) Public Library, died in Boston, Nov. 25, after a short illness. He retired from active duty about a year ago.

Personal Mention

Edwin C. Ramage is now holding the position of resident mechanical engineer at the Hales Bar steam plant of the Tennessee Electric Power Co.

Woodworth Anderson has been transferred by the Worthington Pump & Machinery Corp. from its Seattle office to the office in Salt Lake.

Charles H. Baker resigned from the Sessions Engineering Co., of Chicago, to become managing engineer of the Furnace Engineering Co., with headquarters in New York City.

Jean Boyau has been appointed as resident engineer of the Compagnie Française Thomson-Houston with offices in the International General Electric Co. at Schenectady, succeeding Jean Canivet, who was accidentally drowned July 10.

C. P. Bowie, petroleum engineer in charge of the San Francisco office of the Bureau of Mines, made a trip to Colorado during October to inspect the oil-shale plant the Bureau is erecting near Rifle, on the Denver & Rio Grande R.R. in that state.

Frank M. Doyle, for twenty years connected with the Wheeler Condenser & Engineering Co., and more recently with the Worthington Pump & Machinery Corp., has resigned his position in the engineering sales division of the condenser department of the Worthington company to become vice-president and a director of the G. W. Brownell Engineering Corp., with offices in the Woolworth Bldg., New York City.

William H. Boland has been made mechanical engineering assistant to Francis J. Sill, electrical consultant, Westboro, Mass. Mr. Boland has been engaged for the last five years in steam-engineering work for the Pennsylvania Power & Light Co., with headquarters at the Pine Grove station. Previously, he was in the engineering department of the Bethlehem Steel Corp., Ltd., Bethlehem, Penn.

Harris J. Ryan, of Stanford University, Calif., has been awarded the 1925 Edison Medal by the A.I.E.E., "for his contributions to the science and the art of high-transmission of power." During Professor Ryan's twenty years at Stanford, he has been a pioneering leader in high-voltage transmission. About three years ago the first 220,000-volt power lines were successfully put into commission and Professor Ryan co-operated with the engineers in finding ways to cope with the insulator problems encountered. In 1909 he was consulting engineer for the Los Angeles aqueduct power development.

Society Affairs

The Lehigh Valley Section of the A.I.E.E. will hold a joint meeting with the Engineers' Club at Easton, Pa., on Jan. 20. "Research Today and Tomorrow," by E. B. Craft, vice-president of the Bell Telephone Laboratories will be the attraction.

The Birmingham Section of the A.S.M.E. will hold its Dec. 16 meeting at the Alabama Power Co.'s auditorium. The subject will be "Hydro-Electric Developments," by W. E. Mitchell, vice-president of the Alabama Power Co. An inspection trip through the new modern office building will be taken.

Business Notes

The Chase Companies, Inc., announce that on Nov. 1 they opened a new warehouse in New York City, at 134 Lafayette St., where will be carried a full stock of brass, bronze and copper tubes, sheet and rods.

The Locke Regulator Co., Salem, Mass., has opened an agency at 62 Washington St. North, Boston, Mass., where will be carried stocks of regulator parts, such as pilot valves, diaphragms, cup packings, etc.

The G. M. Basford Co., 17 E. 42nd St., New York City, at a special meeting of its board of directors, elected Roger L. Wensley president and director to fill the vacancy caused by the death of G. M. Basford. Other officers and directors of the company remain the same.

The Superheater Co., 17 East 42d St., New York City, announces the appointment of R. L. Ehrann as district manager of its industrial department, with an office at 923 Union Trust Bldg., Pittsburgh, Pa. John R. LeValley, the former manager, has been assigned to special duties and may be reached through the New York office.

The Allis-Chalmers Manufacturing Co. is opening a branch sales office at Houston, Tex., in charge of R. I. Moore, who was previously located in their Dallas office. After the first of the year the office will be at 1108 Post Dispatch Bldg. The Houston office will be operated as a branch of the Dallas district, of which E. W. Burbank is district manager.

Trade Catalogs

Instruments—James G. Biddle, 1211 Arch St., Philadelphia, Pa. Bulletin 1105, "Jagabi Speed Measuring Instruments," describes and illustrates the operation and use of these instruments.

Oil Engines — Fairbanks, Morse & Co., 900 South Wabash St., Chicago, Ill., have issued Bulletin No. 1020, which, while dealing principally with the design of the firm's own product, discusses the action within the cylinder of both the two- and four stroke-cycle engines. It is well gotten up, profusively illustrated and should be of value to engineers interested in the subject of internal-combustion engines.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institute, Washington, D. C. Annual meeting at Kansas City, Dec. 28-Jan. 2.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at Engineering Building, New York City, Feb. 8-12.

American Institute of Mining & Metallurgical Engineers. Dr. H. Foster Bain, 29 West 39th St., New York City. Annual meeting at Engineering Societies Bldg., New York City, Feb. 15-17.

American Oil Burners Association. Leod D. Becker, 350 Madison Ave., New York City. Annual convention and exposition at Book Cadillac Hotel, Detroit, Mich., April 6-8.

American Petroleum Institute—R. L. Welsh, 250 Park Ave., New York City. Annual meeting at Biltmore Hotel, Los Angeles, Calif., Jan. 19-21.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J,. June 21-25.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 20-22.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Annual meeting at Hotel Statler, Buffalo, N. Y., Jan. 27-29.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring convention at San Francisco, Calif., June 28-30.

Association of Municipal Electric Utilities. S. R. A. Clements, 190 University Ave., Toronto, Canada. Convention at Toronto, Ont., Jan. 27-28.

Engineering Institute of Canada. Richard John Durley, 176 Mansfield St., Montreal, Que. Annual meeting at Toronto, Ont., Jan. 27-29.

Heating & Ventilating Exposition. E. P. Frenz, Hotel McAlpin, New York City. Exposition at new Madison Square Garden, New York City, Mar. 17-23.

Iowa Engineering Society. J. S. Dodds, Box 202, Ames, Iowa. Convention at Mason City, Iowa, Jan. 27-29.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

Midwestern Engineering Exposition, Inc. George E. Pfisterer, 53 West Jackson Boulevard, Chicago, Ill., general manager. Exposition and power show to be held in Chicago, Jan. 26-30.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

National Marine Engineers Beneficial Association. George A. Grubb, 313 Machinists Bldg., Washington, D. C. Convention at Washington, D. C., Jan. 18.

Sesquicentennial International Exposition. Capt. Asher C. Baker, director in chief, Independence Square, Philadelphia. Exposition to be held in Philadelphia, Pa., from June 1 to Dec. 1.

Society of Automotive Engineers. Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at the General Motors Bldg., Detroit, Mich., Jan. 26-29.

Western Association of Electrical Inspectors. W. S. Boyd, 175 West Jackson Blvd., Chicago, Ill. Meeting at Hotel Sherman, Chicago, Ill., Jan. 26-28.

Boilers—E. Keeler Co., Williamsport, Pa. A new catalog on the Keeler boiler has recently been issued. It is well illustrated and shows photos of some of the important installations as well as pictures of the equipment used in the boiler plant, for the manufacture of boilers.

Specialties—The McAlear Manufacturing Co., 1901 South Western Ave., Chicago, Ill. A pleasing and well arranged catalog, No. 28, has recently been published by this firm. It covers the specialties for steam, water, air, gas and oil and is arranged so that the necessary information, picture, and data on any given specialty are placed on one page. Blueprint drawings show typical installations, and rough dimensions for use in placing the specialty in service are included.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Dec. 7, 1925
Pool 1	New York	$2.75@$3.15
Smokeless	Boston	2.50
Clearfield	Boston	1.75@ 2.00
Somerset	Boston	1.85@ 2.15
Kanawha	Columbus	1.55@ 1.85
Hocking	Columbus	1.65@ 2.0
Pittsburgh	Pittsburgh	2.00@ 2.10
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.35@ 2.65
Central, Ill.	Chicago	2.25@ 2.35
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	2.00@ 2.25
Anthracite, Gross Tons		
Buckwheat No. 1	New York	$2.50@$2.75
Buckwheat No. 1	Philadelphia	2.50@ 3.00
Birdseye	New York	....

FUEL OIL

New York—Dec. 10, light oil, tank-car lots; 28@34 deg. Baumé, 5@5½c. per gal.; 36@40 deg., 5½@6½c. per gal., f.o.b., Bayonne, N. J.

St. Louis—Dec. 1, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.10 per bbl.; 26@28 deg., $2.15 per bbl.; 28@30 deg., $2.20 per bbl.; 30@32 deg., $2.25 per bbl.; 32@36 deg., gas oil, 5.53c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Dec. 1, f.o.b. local refinery; 30@34 deg., fuel oil, 5¾c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—Dec. 5, f.o.b. local refinery; 26@30 deg., $1.60 per bbl.

Philadelphia—Dec. 5, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.75@$1.81; 13@19 deg., $1.65@ $1.71 per bbl.

Boston—Nov. 30, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4½c. per gal.; light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati—Dec. 8, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 6¼c. per gal.; 26@30 deg., 6¼c. per gal.; 30@32 deg., 6½c. per gal.

Chicago—Dec. 1, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30 per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.40.

New Plant Construction

Calif., Alhambra—City is having plans prepared for the construction of a 5,000,000 gal. distribution reservoir, deep well, pump house, pumping equipment, etc. T. B. Downer, Ch. Engr., City Water Dept.

Calif. Auburn—Union Ice Co., 354 Pine St., San Francisco, is having plans prepared for the construction of an ice and cold storage plant on High St. here. Estimated cost $60,000. Company engineers in charge.

Calif., Los Angeles—Sun Realty & Investment Co., 742 South Hill St., is receiving bids for the construction of a 12 story office and stores building including steam heating system and elevators at Seventh and Flower Sts. Estimated cost $1,200,000. Curlett & Beelman, 408 Union Bank Bldg., are architects.

Conn., Forestville—City plans the construction of a pumping station in connection with sewer system.

Fla., Palm Beach—Florida East Coast Hotel Co., awarded contract for the construction of a 9 story hotel to Turner Construction Co., 242 Madison Ave., New York, N. Y. Estimated cost $3,000,000.

Ill., Chicago—W. C. Bannerman & Co., 77 West Washington St., will soon award contract for the construction of a 13 story hotel at 426 Belmont Ave. Estimated cost $750,000. R. S. DeGoyler, 307 North Michigan Ave., is architect.

Ill., Chicago—L. C. Cohen, et al, 139 North Clark St., is having preliminary plans prepared for the construction of a 14 story hotel at Rush and Ontario Sts. Estimated cost $1,500,000. E. J. Meles, 109 North Dearborn St., is architect.

Ill., Chicago—G. C. Nimmons & Co., 22 South Michigan Ave., Archts., will receive bids until Dec. 16 for the construction of first unit to service and storage building, including boiler house, part of main loading court, etc., at West 22nd and Throop Sts. for Commonwealth-Edison Co., 72 West Adams St. Estimated cost $1,000,000.

Ill., Chicago—S. J. Gregory, Hammond, Ind., awarded contract for the construction of a 3 story theatre, stores and apartment building at West 25th St. and South 53rd Ave., here, to R. Levine & Co., 820 West 70th St. Estimated cost $1,000,000.

Ill., Chicago—R. Matteson, 565 Diversey Parkway, awarded general contract for the construction of a 15 story hotel at Webster and Sedgwick Sts. to A. Lindstrom, 77 West Washington St. Bids will be taken later for heating, ventilating, electric work, elevators, etc. Estimated cost $2,000,000.

Ill., Great Lakes (Waukegan P. O.)—Bureau of Yards and Docks, Navy Dept., Washington, D. C., will readvertise for bids for the construction of a complete ash handling system for Great Lakes Naval Training Station here. Private plans. Former bids rejected.

Ill., Peoria—Hewitt & Emerson, 1600 Peoples Life Bldg., Archts., will receive bids about Dec. 16 for the construction of a 13 story "Pere Marquette" hotel at Main and Madison Sts., for Emmet C. May & Associates. Estimated cost $1,500,000. H. Trumbauer, Land Title Bldg., Philadelphia, Pa., is consulting architect.

Ill., Warsaw—City will receive bids until Jan. 26, for the construction of a 250 g.p.m. rapid sand filtration plant including pumps, motors and auxiliary equipment, 100,000 gal. tank on tower, mains, etc. Estimated cost $33,000. E. Flad & Co., 1312 Chemical Bldg., St. Louis, are engineers.

Ia., Mason City—Jacob E. Decker & Sons, awarded contract for the construction of a refrigeration plant to M. M. Moen & Co., 19 West State St. Estimated cost $100,000.

Ia., Storm City—City plans the construction of an electric light plant and distribution system. Estimated cost $83,000 and $88,000 respectively.

Md., Baltimore—Johns Hopkins Hospital, Monument and Wolfe Sts., awarded contract for the construction of an 8 story dispensary to M. A. Long Co., 10 West Chase St. Estimated cost $1,000,000.

Md., Baltimore—One Hundred University Parkway Apartment Corp., c/o W. G. Nolting, Pres., Keyser Bldg., awarded contract for the construction of a 9 story apartment including heating and ventilating systems at University Parkway and Canterbury Road to Consolidated Engineering Co., 20 East Franklin St. Estimated cost $1,000,000.

Mass., Boston—C. H. Blackall, 20 Beacon St., awarded contract for the construction of a 17 story hotel at Tremont and Hollis Sts., to F. T. Ley, Inc., 230 Boylston St. Estimated cost $2,000,000.

Mass., Boston — Massachusetts General Hospital, plans the construction of a 13 story hospital on Fruit St. Estimated cost $1,000,000. Coolidge, Shepley, Bulfinch & Abbott, Ames Bldg., are architects.

Mass., Lynn—General Electric Co., Western Ave., will build a turbo-generator test base by day labor. J. G. Trudinger, Western Ave., is engineer.

Mass., Roxbury (Boston P. O.)—Atlantic Screen & Wood Products Co., 25 Vale St., awarded contract for the construction of a factory, boiler house and garage, to R. A. Murray, 83 Clement Ave., Rosindale. Estimated cost $50,000.

Mass., Sharon—Sharon Box Co., is in the market for a 6 x 4 x 6 duplex steam pump.

Mass., Somerville (Boston P. O.)—G. Vatigian, Odd Fellows Bldg., plans the construction of a 10 story hotel at 291-297 Broadway. Estimated cost $1,250,000. J. A. Tuck, Park Square Bldg., Boston, is architect.

Mich., Detroit—Bonnah & Chaffee, 300 Barlum Bldg., Archts., are receiving bids for the construction of a 21 story hotel including steam heating equipment at Cadillac Square, for J. J. Barlum, 206 East Grand River Ave. Estimated cost $2,500,000.

Mich., Highland Park—Highland Building Corp., 1200 Washington Blvd., Detroit, awarded contract for the construction of twenty 5 story apartment buildings, including separate boiler plant on Woodward Ave. here to Jones McNally Co., 1901 Washington Blvd., Detroit. Estimated cost $3,000,000.

Minn., Fort Snelling—U. S. Veterans' Bureau, Room 791, Arlington Bldg., Washington, D. C., will receive bids until Jan. 26, 1926, for the construction of a group of buildings including a laundry, boiler and storehouse building, etc., at U. S. Veterans' Hospital, here. Separate bids will be received for heating, electric work, elevators, ice-making and refrigerating plant, etc.

Miss., Meridian—Tutt Ice Co., awarded contract for the construction of an ice-manufacturing plant to McArthur & McKenmore. $35,000.

Mo., St. Louis—Missouri Glue Co., 5310 North Second St., is in the market for several 25 to 30 hp. motors, a.c., 400 v. 25 cycle, low speed.

Mo., Senath—City will receive bids until Dec. 21 for a 75,000 gal. tank on tower, two deep wells, pump house, two deep well turbines, mains, etc., also two sewage pumping stations, one 90, and one 125 g.p.m. motor driven pumps, Imhoff sewage disposal plant, etc. Estimated cost $65,000. W. C. Burke & Co., 1312 Chemical Bldg., St. Louis, are engineers.

Neb., Columbus—Northwestern Public Service Co., plans addition to electric plant, including new turbines, machinery, etc. Estimated cost $100,000.

Neb., Omaha—City Ice & Fuel Co., 1935 Euclid Ave., Cleveland, O., awarded general contract for remodeling and new building for ice and cold storage plant at 13th and Chicago Sts., here, to Parsons Construction Co., Burgess-Nash Bldg. Ice machinery, freezing tanks, etc., will be required. Estimated cost including equipment $100,000.

N. J., Allenhurst—Borough, M. D. Pyle, Clk., plans to purchase a 3,000 gal. pump and motor for pumping station. Estimated cost $5,000.

N. J., Newark—Military Park Construction Co., c/o Polhemus & Coffin, 15 East 40th St., Archts. and Engrs., plans the construction of an 18 story hotel and theatre building on Park Place. Estimated cost $3,000,000.

N. Y., Brooklyn—Coney Island Hospital, Ocean Parkway, will soon receive bids for the construction of addition to hospital. Estimated cost $1,000,000. Dodge & Morrison, 160 Pearl St., New York, are architects and engineers.

N. Y., Brooklyn — Independent Assets Corp., 885 Flatbush Ave., plans the construction of a 15 story hotel. Estimated cost $1,000,000.

N. Y., Brooklyn—Kings County Hospital, Clarkson St., will soon receive bids for the construction of addition to hospital. Estimated cost $1,000,000. Dodge & Morrison, 160 Pearl St., are architects and engineers.

N. Y., Brooklyn—State Hospital Comn., Capitol, Albany, will receive bids until Dec. 23 for electric generator for power house, at Brooklyn State Hospital, here.

N. Y., New York—Ivy Construction Co., c/o L. A. Abramson, 46 West 48th St., Archt. and Engr., will build a 9 story apartment at 206 West 78th St. by day labor. Estimated cost $300,000.

N. Y., New York—One Thousand Eighty One Park Avenue Corp., c/o Schwartz & Gross, 347 5th Ave., Archts. and Engrs., is having plans prepared for the construction of a 15 story apartment. Estimated cost $1,000,000.

N. C., Kinston—Water & Light Commission, J. May, Comr., plans improvements to waterworks including deep wells, electric pump, additional reservoir facilities, etc.

N. C., Monroe—City plans to expend $200,000 for improvements to water and light systems including an impounding reservoir, etc., at Richardson's Creek near here. C. E. Houston, mayor.

N. C., Morehead—City has authorized $75,000 bond issue for the construction of an electric light plant.

Okla., Fort Cobb.—City plans an election Jan. 5 to vote $40,000 bonds for the construction of a new waterworks system including a deep well pump, etc. V. V. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Pa., Philadelphia—United Gas Improvement Co., Broad and Arch Sts., awarded contract for the construction of a 14 story office building at 1409-1415 Arch St., to Murphy Quigley Co., 1524 Sansom St. Estimated cost $1,000,000.

S. D., Sioux Falls—City defeated $300,000 bond issue for the construction of a municipal electric plant.

Tenn., Dyersburg—Dyersburg Ice & Coal Co., plans the construction of an ice and cold storage plant. Estimated cost $100,000.

Tex., Alamo—City voted $25,000 for waterworks system including pumping equipment, mains, etc. F. J. Denzer, mayor.

Tex., Engle Pass—Kifuri Bros., plans the construction of a 15 ton ice plant. Estimated cost $50,000. Private plans. Machinery will be required.

Tex., Kemp—City voted $85,000 bonds for improvements to waterworks including reservoir, pumping equipment, etc. M. Allen, mayor.

Tex., Luling—Texas Central Power Co., A. B. Sawyer, Dist. Mgr., Cuero, is having preliminary plans prepared for improvements to waterworks including new pumping machinery, etc. Estimated cost $25,000. Company engineers in charge.

Tex., San Antonio—W. P. Waldrep, c/o Waldrep Bldg., Tulsa, Okla., is having plans prepared for the construction of a 10 story hotel including steam heating and refrigeration systems at Nopal and Steves Sts., here. Estimated cost $2,500,000. Private plans.

Tex., Wichita Falls—City plans improvements to waterworks including pumping equipment, etc. Estimated cost $200,000. T. W. Taylor, University of Texas, Austin, is engineer.

Wis., Delta—C. F. Wolf, Birchwood, has acquired 1480 acres of land and plans the construction of a trout hatchery also dam and equipment to furnish power and light for buildings here. Engineer not selected.

Wis., West Bend—Washington County, R. Kraemer, Clk., has appropriated $6,000 for the purchase of two new boilers for county power and light plant.

Ont., Lakefield — Canada Cement Co., plans a hydro-electric development, 2 units 16 ft. head, 900 hp. each, including power house, dam, transformer house, turbines, generators, switches, pumps, motors, conduit, meters, electric crane, circuit breakers, choke coils, etc. Estimated cost $250,000. Kerry & Chace, Confederation Life Bldg., Toronto, are engineers.

Australia, Melbourne — Victorian Government Railways, will receive bids until Feb. 10, 1926, for two complete sets of mechanical coal handling plants.